# Surveying and Mapping

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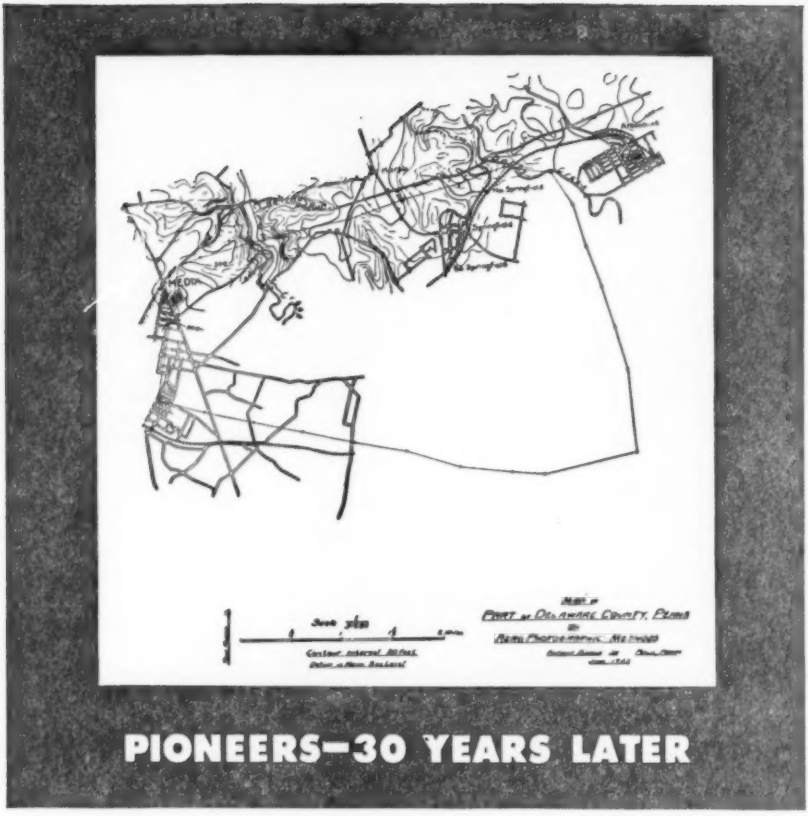
*July – September 1952*

*Quarterly Journal*

AMERICAN CONGRESS ON SURVEYING AND MAPPING

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SURVEYING AND MAPPING is the official journal of the Congress and is published quarterly during the months of March, June, September, and December. The Congress welcomes articles and interesting news items for publication in its journal. Manuscripts should be sent to the appropriate member of the Publications Committee.

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## Thirteenth Annual Meeting

MARCH 23, 24, 25, 1953

*Shoreham Hotel, Washington, D. C.*

# SURVEYING AND MAPPING

A. L. Shalowitz, *Editor-in-Chief*
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A Quarterly Journal
Devoted to the Advancement of the Sciences
of Surveying and Mapping

Volume XII, No. 3
July–September 1952

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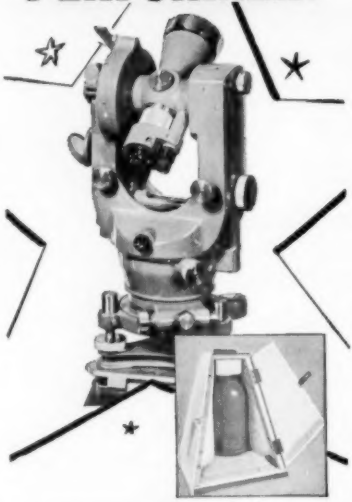

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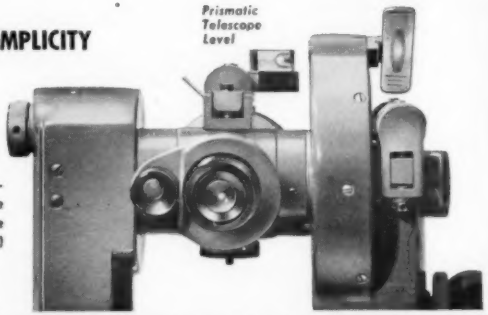


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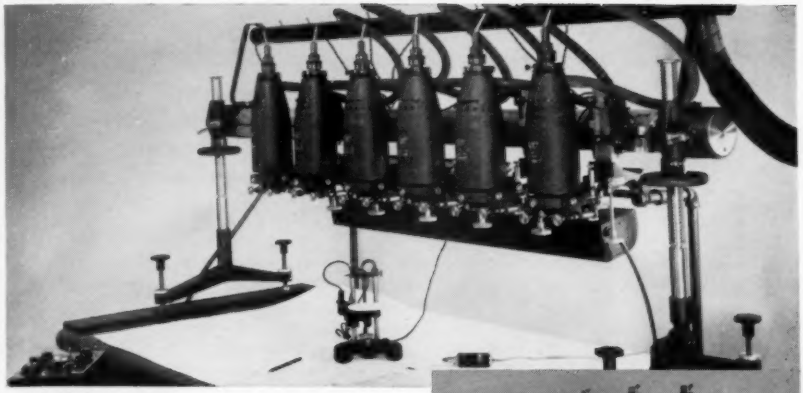

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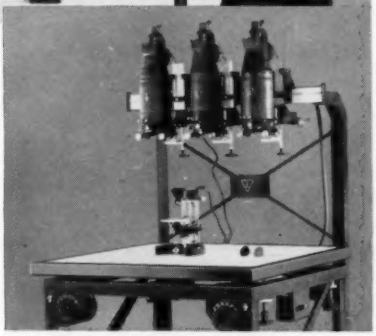

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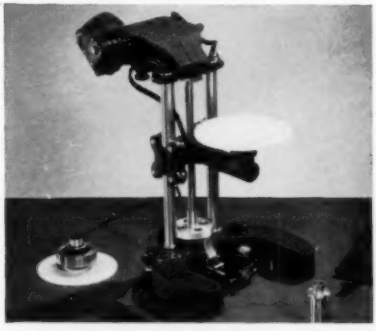

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*Reporting on Unusual Surveying Problems and Their Solutions*

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## A Report to Surveyors

**It has been** more than a year since the first in this series of "unusual surveying problems and their solutions" appeared in your engineering journals.

*Massachusetts survey*

The initial page in "The Surveyor's Notebook" showed how a Commonwealth of Massachusetts survey party used captive pilot balloons to get initial lines between stakes separated by heavy timber.

Since then, "The Surveyor's Notebook" has developed into a forum through which veteran field men voice their experiences in solving tough problems and eliminating common surveying hazards—for the benefit of other surveyors and engineers.

**A Nebraska** deputy county surveyor, for example, has relieved many a headache by explaining how he quickly determined a quarter-section line which was completely blocked by railroad cars. So did Stan Shartle of Danville, Indiana, with his account of leveling over 10 feet of corn.

*Joe Thoma*

One month, Joe Thoma, the prominent cadastral engineer, gave his remedy for "frozen" tripods; later told of the advantages of the solar transit.

These stories—and letters commenting on them—have come from all over the nation.

**Niagara Falls'** Corps of Engineers related how it made the first accurate survey of the Niagara River bed with the aid of unusual transit practices. The Chief Locating Engineer of North Carolina has created a great deal of discussion with his plan for improving land survey records.

Through "The Surveyor's Notebook", Gordon Ainsworth told how to get an oil pipeline laid in record time by using a few tricks of the trade.

*Gordon Ainsworth*

Dick Merritt described the unusual problems of surveying in the Arctic, while Jim Caputo showed how aircraft plants use transits. (His story led to the development of a new Gurley instrument for the industry.)

**A great many** surveyors have written to us saying that the experiences they read about in "The Surveyor's Notebook" have helped them solve their own field problems. And a number of the engineering colleges have requested copies regularly as classroom aids.

Gurley will continue to be notekeeper for the series; welcomes your comments and suggestions—and, of course, your own experiences.

*The first year's stories and surveying tips have been gathered together and reprinted in permanent form. Write for your free copy of* "The Surveyor's Notebook" *collection.*

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Number 3

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THE LADIES' LUNCHEON HAS COME TO BE A REGULAR FEATURE AT THE ANNUAL MEETING

# The Twelfth Annual Meeting

THE Twelfth Annual Meeting of the American Congress on Surveying and Mapping took place at the Shoreham Hotel in Washington, D. C., during the 3 days, June 11, 12, and 13, 1952. The total paid registration was 728, which is the largest number that has ever attended one of these annual meetings. Bigger and better is getting to be a habit, and with the recent phenomenal growth in membership, it should be expected. Incidentally, Murray Y. Poling is general chairman for the Thirteenth Annual Meeting and has set his goal at 1,500 registrations. Everyone who attended the Twelfth Annual Meeting enjoyed it and profited by it. If you are one of the unfortunate ones who was prevented from attending, make a resolution now to get to the Annual Meeting next year.

The registration desk opened at 8:30 a.m. Wednesday and President George H. Harding presided at the official opening of the exhibits which are described below under a separate heading. The first part of the morning was devoted to registration, viewing the exhibits, and renewing old acquaintances.

## Plenary Sessions

The Congress was officially opened at 10:40 a.m. Wednesday by President Harding who welcomed the members and guests present and spoke briefly about the affairs of the Congress.

The program was arranged so that each Technical Division had half of one morning or afternoon plenary session at which to present papers or panel discussions of interest to its members; this was so that programs of interest would not conflict with one another.

During the meeting there were 5 panel discussions, 26 papers or talks, and 2 motion pictures. You have all had an opportunity to examine the program so that a simple tabulation of the titles of the papers would serve no purpose here. Most of the papers will eventually be published in the Journal for all to read.

After the President's opening remarks, a panel discussion followed on the subject "Map Appreciation and Use," Fowler W. Barker of the Association of Professional Photogrammetrists acting as moderator. It will be recalled that there was a panel discussion on this same subject at the Eleventh Annual Meeting. ACSM has a permanent committee working on this subject.

Before closing the morning session, President Harding appointed a Resolutions Committee composed of the six chairmen of the Technical Divisions and asked Carroll F. Merriam, chairman of the Control Surveys Division, to act as chairman of the Resolutions Committee.

PRESIDENT HARDING OPENS THE TWELFTH ANNUAL MEETING

The first half of Wednesday afternoon was devoted to three papers and a panel discussion pertinent to the Instruments Technical Division, W. L. Egy, chairman, presiding. The subject of the panel discussion was "The Instrument Maker and Instrument User," Warren T. Ellis, U. S. Air Force, moderator. This discussion brought out many points of general interest, for all members who are not instrument makers are certainly instrument users.

During the second half of the afternoon, the Property Surveys Division had the platform, R. M. Berry, chairman, presiding. Again there were three papers and one panel discussion. The subject of the panel discussion was "Advantages of Local Professional Surveyors Organizations," W. B. Williams, Michigan Society of Engineers, acting as moderator.

When the plenary session was resumed Thursday morning the program for the first half of the morning was in the hands of the Cartography Division, Gordon Littlepage, chairman, presiding. Four papers were followed by a travelogue by Newman Bumstead, National Geographic Society, entitled "Around the World in Eighty Days."

The cartographic part of the program was followed by a color motion picture entitled, "The Inter-American Highway Through Central America and Panama," which was exhibited through the courtesy of the Bureau of Public Roads. This was followed by one paper before the noon adjournment.

The first afternoon paper was by the Honorable Robert R. Rose, Jr., Assistant Secretary of the Department of the Interior, whose subject was "Mineral Resources for Defense." This was followed by the session devoted to the Topography Division, C. S. Maltby, chairman, presiding. Four papers were presented, followed by a panel discussion on the subject "Selection of Contour Intervals," A. O. Quinn, Aero Service Corporation, acting as moderator.

The business meetings of the Technical Divisions were held simultaneously during the first hour Friday morning and the plenary session was not resumed until 10:00 a.m. when the Control Surveys Division had charge of the proceedings, Carroll F. Merriam, chairman, presiding. Five papers were given.

The first paper Friday afternoon was entitled "Research and the Future" presented by Dr. Clyde Williams, Director, Battelle Memorial Institute, Columbus, Ohio. This was followed by the Education Division's part of the program, Prof. Russell C. Brinker, chairman, presiding. Three papers were presented, followed by a panel discussion entitled, "Surveying Techniques—Tricks of the Profession."

After the business meeting and a brief acceptance speech by the president-elect, the 1952 Annual Meeting was declared adjourned.

## Business Meeting

President Harding opened the business meeting and announced that, in view of the lateness of the hour, reports of officers and standing committees would be dispensed with, but would be published in the Journal. These reports are in this issue under Congress News.

The Tellers Committee then reported. A. C. Kalbfleisch, Geological Survey, chairman, reported that 1,004 ballots had been received. This is an increase of 35 percent over the number received last year and reflects the growth of ACSM. He noted that ballots had been received from 14 foreign countries, as follows: 4 South American countries, 4 Central American and Caribbean countries, 3 European countries, and Israel, the Philippine Islands, and Canada. The balloting resulted in the election of the following for 1953:

*Officers*

Rear Admiral Robert F. A. Studds, *President*
Benjamin E. Beavin, Sr., *Vice President*

*Directors*

(Two-year Terms)

Frank S. Borden — G. W. Herzog
L. L. Funk — W. H. Miller
Franklin G. Williams

A total of 963 ballots were returned relative to the proposed amendment to the constitution for an increase in dues—619 in favor, 344 opposed. This defeated the proposed change, inasmuch as a 75 per cent majority is required for an amendment to the constitution.

The report of the Resolutions Committee was then made by chairman Merriam. Two resolutions were recommended for the consideration of the Congress and these were adopted, and are printed in this issue under Congress News.

## Directors' Meeting

The Board of Direction met at 8:00 p.m. Tuesday, the evening before the official opening of the Annual Meeting, to review last-minute reports of the arrangements for the meeting and to attend to other pre-Congress business.

President Harding announced the appointment of Murray Y. Poling as general chairman of the Thirteenth Annual Meeting, and the latter presented a proposed list of committees for this meeting which was approved by the Board of Direction. Mr. Poling also spoke briefly on plans for the meeting and the possibility of holding it in March instead of June.

The Board of Direction met at 10:00 a.m. Saturday, after the Congress, to review the actual events of the Annual Meeting, and to attend to other business. The new officers and directors for 1953 attended this meeting to familiarize themselves with the conduct of the affairs of ACSM.

PRESIDENT HARDING (LEFT) AND PRESIDENT-ELECT STUDDS CHAT DURING AN INTERLUDE IN THE PROCEEDINGS

PANEL ON "SURVEYING TECHNIQUES—TRICKS OF THE PROFESSION"

A committee on Constitutional Study and Revision was appointed, comprising William T. Pryor, chairman, Marshall S. Wright, Talbert Abrams, Murray Y. Poling, and Walter S. Dix, and a statement of the duties of the committee was approved.

## Technical Division Meetings

The Control Surveys Division and the Property Surveys Division held separate technical annual meetings simultaneously on Thursday evening, and five Technical Divisions—all except Control Surveys—held their short annual business meetings at 9:00 a.m. Friday morning. Brief reports of these meetings follow:

### CARTOGRAPHY DIVISION

The business meeting of the Technical Division on Cartography convened at 9:00 a.m., in the Terrace Banquet Room, Gordon B. Littlepage, chairman, presiding.

The chairman outlined the structure of the division and summarized its activities to date. He reported that local meetings have been held in the Washington area in which prominent speakers have contributed invaluable information on timely subjects to larger and larger audiences. Because of the ever-increasing popularity of these local get-togethers they will be held at least twice a year. He requested that the members forward suggestions for improvement of the programs for these meetings.

W. C. Crump, chairman of the Tellers Committee, reported that 117 ballots were received from the membership as compared with 78 for the previous year. Robert L. Moravetz was elected chairman for the calendar year 1953; Joseph P. Dunich, Arthur F. Striker, and Arthur J. Sweet were elected directors.

The new chairman was introduced to the audience and in a brief speech of acceptance emphasized his complete agreement with the present aims and activities of the division. He emphasized the importance of holding local meetings, and of extending the activities of the division into the field.

M. S. A. Delaney, chairman of the Technical Standards Committee, reported steady progress on a program designed to provide the membership with a comprehensive report of the various technical methods employed by government and private map-making units to produce maps and charts.

The Research and Development Committee prepared a summary tabulation of research developments in the field of cartography and related sciences, which was published in a recent issue of SURVEYING AND MAPPING. The chairman stated that the maintenance and improvement of this tabulation would be the principal item on the committee's agenda during the coming year.

Joseph P. Dunich, chairman of the Membership Committee, reported that the division now has a membership of approximately 300. He urged the members to help recruit new members to the Congress.

The chairman paid tribute to the Program Committee for its untiring efforts in developing programs for both the local division Spring Meeting and for the Annual Meeting.

Kalevi Kirvesniemi, a new member from Finland, stated that small countries such as Finland were (because of economic and other factors) in great need of new ideas, methods, and procedures relating to cartography and photolithography. He expressed the hope that many of the answers he is seeking will be found in past and future issues of the Journal.

### CONTROL SURVEYS DIVISION

The Annual Business Meeting of the Technical Division on Control Surveys convened at 8 p.m., Carroll F. Merriam, chairman, presiding.

Murray Y. Poling, general chairman of the 1953 Annual Meeting, spoke briefly on the general plans for next year's meeting.

Prof. Milton O. Schmidt of the University of Illinois was elected to serve as director for the years 1953–55.

Homer C. Fuller, of the Army Map Service and chairman of the Committee on Research and Development, reported that, during the past 2 years, the committee had investigated the use of subtense methods for the extension of supplemental horizontal control. It reviewed foreign literature on this subject, in addition to studies made in the United States. Several other items of improvement of techniques with the use of modern instruments were included in his report.

Inasmuch as there was no other formal business, a round-table discussion was held on the extension of horizontal and vertical control at the State level.

Elmer C. Houdlette reported on the outstanding work that has been accomplished in Massachusetts and told how the work had

been started as a cooperative project between State and Federal organizations, and then finally continued independently with funds made available by the State legislature. He told of the extensive use that is made of the horizontal and vertical control points within his State. The horizontal control network includes 250 first-order triangulation stations, 400 second-order stations, 75 intersected points, and about 4,000 miles of traverse, with 5,500 marked points, having average closures of about 1 part in 35,000. The leveling net consists of 10 to 12 thousand miles of first-order leveling.

Phil M. Miles, Chief of Maps and Minerals Division, Agricultural and Industrial Board of Kentucky, told of the increasing interest being shown in the use of control data. The cooperative mapping program of the State and Federal agencies, which was started in Kentucky a few years ago, is doing much to stimulate interest in all phases of cartography, and there is an increasing number of requests by local engineers for coordinated control data. Mr. Miles' office endeavors to make available to local engineers the data for control points in Kentucky established by the various Federal agencies. Mining corporations use rectangular coordinate systems extensively but Mr. Miles expressed the hope that these data would be transferred to the State Plane Coordinate System.

Robert G. Blanchard, of the Bureau of Geology and Topography of New Jersey, reported on what has been done in his State and the means for distributing control data to the local engineers. The Federal networks of horizontal and vertical control in New Jersey have been subdivided by traverse and leveling to the extent that control points are easily accessible to engineers. The control data are published in pamphlet form and are readily available to anyone needing such information. Mr. Blanchard exhibited sample copies of county diagrams and descriptive reports on the locations of traverse stations, and distributed pamphlets explaining how to obtain control data in New Jersey.

George W. Cassell of the Maryland Bureau of Control Surveys and Maps told of the increasing service which this bureau is giving, not only to local, county, and State agencies but also to Federal agencies operating within the State, which need accurate and coordinated survey data for the descriptions of property boundary lines. The method of filing control data on the basis of a coordinate index was described by William L. Shoemaker, of the same bureau, and the general plan for furnishing copies of survey data to engineers was explained. A graphical method was described for determining the accuracy of a horizontal control point as indicated by the intersections of the lines of observations.

Written reports had been received from other States. Capt. A. M. Sobieralski, U. S. Coast and Geodetic Survey (Retired), reported that a Washington State Board of Surveying and Mapping had been established in 1951 under the Engineering Department of the Department of Public Lands, but that as yet no appropriation had been made to carry out its activities. He submitted a copy of the general regulations governing the extension and use of local control. The membership of the Advisory Board comprises: Capt. A. M. Sobieralski, chairman, Seattle; Prof. Hiram Chittenden, University of Washington; Benjamin J. Hayes, City Engineer, Hoquiam; C. V. Payne, Spokane; and H. W. Kramer, Seattle.

Paul J. Dube, Cartographic Engineer of the Department of Highways in Nevada, wrote about the cooperative work that has been done within his State by the Highway Department and Federal mapping agencies. In many places the Highway Department has had to extend local control over rather large areas between the widely spaced points of the Federal networks. Highway locations, as well as railroad, power line, and telephone traverses, are adjusted into the State Plane Coordinate System. The field survey parties of the Highway Department are well equipped to carry out their assignments in areas of rugged terrain, such as are found in Nevada.

Jon S. Beazley, Photogrammetric Engineer, wrote about a program of education which has been carried out in Florida. A working manual on the application of the State system of coordinates had been prepared for field personnel, and lectures and discussions were held in each district. There is no agency in Florida extending control at the State level, but full use is being made of all control established by the Federal agencies.

Charles D. Robertson, of the California Division of State Lands, wrote a report on the work being done by that organization. The Division establishes second-order triangulation stations approximately 1 mile apart along waterways on which structural improvements are being made. Traverse stations are located

CANDID SHOTS AT THE TWELFTH ANNU

FTH ANNUAL MEETING AT WASHINGTON, D. C.

approximately midway between the triangulation points. These surveys are adjusted into the Federal network, and the final values are computed on the State system of Lambert coordinates. Copies of the results are made available to all State and local agencies.

After a period of discussion, J. E. R. Ross, Dominion Geodesist of Canada, was asked to make a few comments, and he spoke briefly of the difficulties which are encountered in Canada in the extension of control surveys.

In summarizing the reports that were presented and the discussion which followed, four basic thoughts are evident: First, there is an increasing demand by local, county, and State agencies for survey data. It is not possible for the Federal mapping agencies to meet these requests and State organizations are recognizing that it is their responsibility to furnish this service to local groups. Second, the precision required in the extension of local surveys is such that all control data must be coordinated. The breakdown of horizontal control surveys within a State has been made on the State Plane Coordinate System so that these data can be used by all engineers. The same procedure applies to the vertical control and the Federal network of leveling. Third, ACSM has a distinct responsibility in promoting interest at the State level in the extension of control so that the State legislatures will recognize the need and provide the necessary funds for making such work possible. Fourth, there are areas within the United States where it is still necessary for Federal agencies to extend horizontal and vertical control so that the basic framework of control over the country will be of uniform strength and coverage throughout the entire structure. The cooperation which has been shown by the State and Federal agencies has been responsible for much of the progress that has been made during the past 25 years and it may be expected that this spirit of cooperation will continue during the years to come as the National Mapping Program becomes a reality.

## EDUCATION DIVISION

The business meeting convened at 9:00 a.m., Russell C. Brinker, chairman, presiding. The chairman explained the *pro tem* basis of operation of the last year and how the by-laws were prepared and approved.

Three directors were elected to form the 1953 directorate of the division, as follows: Prof. Lawrence Perez, Pennsylvania State College, chairman, (1-year term); Prof. Henry B. Aiken, University of Tennessee, (2-year term); and Brother B. Austin Barry, Manhattan College, (3-year term).

The Education Division functions on the "continuing directorate" system. Each year the director with the longest service will be chairman, and henceforth one new director will be elected each year for a 3-year term.

A space on the dues statement has been obtained to permit members to indicate their preference for the Education Division. This should increase the membership of the division. The need for a new roster of the membership in the Congress was discussed and the fact that one would be published soon was brought out.

Two questionnaire surveys prepared and circulated by the chairman of the division were noted: A compilation of the surplus surveying and photogrammetric equipment available for trade at the various engineering schools and the items desired in return; and a compilation of the summer surveying camps and schools that needed additional teachers and men who wished to teach at other schools.

The remainder of the meeting was devoted to a discussion of what the activities of the division should be in the next year and how the division could best operate.

A possible change in the date of the Annual Meeting was discussed and a show of hands indicated that those present were overwhelmingly in favor of a date in March.

## INSTRUMENTS DIVISION

Carl W. Keuffel, of Keuffel and Esser Company, was elected chairman for 1953 and Clifford A. Thorpe, Jr., of C. L. Berger and Sons, Inc., was re-elected secretary.

There was some discussion about the hours that the exhibits were open. The consensus seemed to be that they were not open too long.

The chairman of the Publications Committee spoke briefly about the new policy which had been adopted to accept advertising in the Journal (a notice of this appeared in the April–June issue of the Journal), and assured the members of the division that this policy was in no way an indirect method of getting the commercial companies to help support ACSM. He stated that he hoped every company would consider the matter purely from the viewpoint of its advantage to the company.

It was voted to change the name of the Division from Surveying Instruments Division to simply Instruments Division.

## PROPERTY SURVEYS DIVISION

The Thursday evening meeting convened at 8:00 p.m., in the Terrace Banquet Room, R. M. Berry, chairman, presiding. The chairman declared the meeting open for any matters of interest to the members as long as the subject was surveying. The assembled group responded nobly and at one time or another almost every subject of interest to property surveyors was discussed. A number of those present spoke on the advantages of local organizations—those in whose areas there are now local organizations explaining how they had been formed and how they function, and those where there are no organizations deploring this fact and seeking advice as to how to proceed.

A spirited discussion arose as to whether the Federal Government had any authority over the financial arrangements that a surveyor has with the persons he employs and various speakers told of their experiences in this matter.

Murray Y. Poling, general chairman for the Thirteenth Annual Meeting, spoke briefly about his plans and asked for a show of hands in favor of a meeting in the spring instead of midsummer. The vote in favor of a spring meeting was almost unanimous.

The chairman of the Publications Committee told the group that about 75 percent of the new members coming into ACSM now are property surveyors and he pointed out the need for more and better articles of interest to property surveyors for publication in the Journal.

R. M. Berry was re-elected chairman of the division for another year at the business meeting Friday morning. Most of this session was taken up with reports and discussions on the preparation of a manual for property surveyors.

## TOPOGRAPHY DIVISION

J C Carpenter, chairman of the committee on Topographic Mapping Along the National System of Interstate Highways, reported as follows:

At the Eleventh Annual Meeting last year a panel discussion (published elsewhere in this issue) was held on the subject of "Topographic Mapping Along the National System of Interstate Highways." After the discussion, at an informal meeting of the members of the panel, I asked Captain Hemple, Colonel Ladd, and Mr. Lyddan if they would serve on a committee to deal with this matter, if and when such a committee were formed, and they all agreed to serve. With the committee on its way to organization, it seemed proper for me to obtain the endorsement of the Bureau of Public Roads before proceeding too far with the program. Mr. FitzGerald, President of the Congress, talked to Mr. MacDonald, Commissioner of the Bureau, and he agreed to my appointment as chairman of the committee. On October 2, 1951, Mr. FitzGerald asked me to serve, and I accepted.

With the help of Mr. MacDonald and Gen. James A. Anderson, president of the American Association of State Highway Officials, arrangements were made for my appearance before the Executive Committee meeting of the Association on October 23, 1951. An outline of the proposed program for topographic mapping for highway location was presented to the Executive Committee and they voted to endorse the project, and instructed their Resolutions Committee to prepare a resolution for adoption of the general meeting of the Association. The resolution was prepared and accepted by the Resolutions Committee, but they elected not to read it at the final meeting of the Association on October 26.

As the project now stands, we have half of a committee made up of map-makers, but no highway engineers. The sentiment of the few highway engineers I have talked to is that they have so many much more important problems of immediate urgency, such as the matter of obtaining steel for construction, that they cannot see the necessity for making arrangements for maps they may need 5 to 20 years from now. They are somewhat suspicious that this may be a scheme to obligate them to spend some of their highway funds, which are badly needed for construction, as cooperative funds in a mapping program. There is also an undercurrent of feeling that where strip topography is needed it can be obtained through aerial surveys of the area where a project is proposed. I have not found any highway engineers who would develop sufficient enthusiasm to warrant their appointment on the committee.

The project has much merit and should be continued. We need a vigorous program of information on the future mapping program for the country to convince the highway engineers that the maps will be made, with or without their suggestions for the location of the work, scales that will be suitable for highway location, etc. With time, and careful presentation of these facts, I feel sure we will obtain the support of responsible highway officials and that much benefit will accrue to the highway industry and to the country.

The Membership Committee reported that there are now 520 members listed on the rolls of the Topography Division.

A joint meeting of the Cartography and Topography Divisions was held in the Interior Department Auditorium at 8:00 p.m. on the evening of Wednesday, April 2. The divisions presented a motion picture entitled "Preparation of Topographic Manuscripts for Reproduction," by the U. S. Geological Survey, and two papers, one by Robert H. Randall, Jr. on "Modern Navigation—A Challenge to the Cartographer," and another by Comdr. Karl B. Jeffers on "Operation Coldfoot." The film and the two papers provided a very stimulating evening for the well-attended meeting.

Another joint meeting with the Cartography Division is planned for this fall.

Results of the annual election of officers are as follows: Shirley V. Griffith, chairman for 1953; Comdr. Charles A. Schanck, director (2-year term); Jon S. Beazley, director (3-year term); and Charles W. Buckey, director (3-year term).

## Social Activities

A luncheon for the ladies was held on Wednesday, June 11, in the Louis Seize Room. This was attended by 57 wives and friends of members of ACSM. This group represented many States, as well as Hawaii and Canada. The speaker was Mrs. Pattie Field of the Passport Division of the Department of State. She described, in an informal and entertaining manner, her experiences in Holland where she served as the first woman vice-consul ever to be appointed.

These luncheons, which have become an annual feature, are proving highly successful and are anticipated with pleasure by the distaff side of the Congress.

After the adjournment of the plenary session on Wednesday, 301 members and guests made their way to the West Ballroom, where the cocktail hour provided an opportunity for relaxation from the more serious program of the day. This year there were no meetings scheduled after the cocktail party, but at 7:45 p.m. the color motion picture "Highway in the Sky" was shown by courtesy of the Aeronautical Chart and Information Service.

The Annual Meeting was fittingly closed by the Annual Banquet which took place in the West Ballroom on Friday evening. President Harding greeted the 151 members and guests attending this traditional dinner and program of music and entertainment. He expressed high hopes for the future of the Congress and personally thanked all those who were responsible for the success of the Twelfth Annual Meeting. He paid tribute to Robert H. Randall, the first president of the Congress, and called upon Rear Adm. R. F. A. Studds, the president-elect, to greet the members and guests. In his remarks, Admiral Studds expressed his sincere appreciation of the honor of being elected president of such a professional organization and assured the members that he would give it his active support in order to continue the success and accomplishments of his predecessors.

During the dinner, music was provided by Tiny Meeker's Orchestra and included the various State and country songs of the guests present. Special music and entertainment was furnished by Beverly Walsh and Ed Camp.

After the dinner most of the guests proceeded to the Terrace Banquet Room where they were joined by others for the Congress dance. Music was furnished by Tiny Meeker's Orchestra and included several specialty numbers in which those showing the best rhythmic talents were awarded prizes.

## Instrument Exhibit

The Annual Meeting actually began with the official opening by President George H. Harding of the instrument exhibits at 9:00 a.m., on June 11. This year the exhibit booths were in the Main Ballroom where they were less crowded and more accessible. The exhibit was much larger and broader in scope than any such previous exhibit—36 commercial concerns were represented—and was particularly interesting and educational to those in attendance. Many of the exhibitors had instruments and equipment set up so that those interested could operate and examine them as much as desired. It was observed that the exhibit hall, at all times during the meeting, was very well patronized, so well that one sometimes had difficulty in examining an instrument in which he was particularly interested.

The exhibit hall was open daily from 8:30 a.m. to 9:00 p.m. The following companies presented exhibits:

THEO. ALTENEDER & SONS, Philadelphia, Pa.
BATHEY MANUFACTURING CO., Plymouth, Mich.
BAUSCH & LOMB OPTICAL CO., Rochester, N. Y.
C. L. BERGER & SONS, INC., Boston, Mass.

Brunson Instrument Company, Inc., Kansas City, Mo.

Consolidated Photo Engravers & Lithographers Equipment Co., Chicago, Ill.

Robert A. Cummings, Jr., & Associates, Pittsburgh, Pa.

Eugene Dietzgen Co., Washington, D. C.

Direct Reproduction Corp., Brooklyn, N. Y.

Emmert Manufacturing Company, Waynesboro, Pa.

F/8 Filotecnica Salmoiraghi S.P.A., New York, N. Y.

Geo-Optic Company, Brooklyn, N. Y.

W. & L. E. Gurley, Troy, N. Y.

Hastings Instrument Company, Inc., Hampton, Va.

Jarrell-Ash Company, Boston, Mass.

Keuffel & Esser Co., Hoboken, N. J.

Marchant Calculating Machine Co., Oakland, Calif.

Mark Specialty Company, Rochester, N. Y.

Don A. Moler, Washington, D. C.

Monsen-Chicago, Inc., Chicago, Ill.

Motorola, Inc., Chicago, Ill.

Geo. F. Muth Co., Inc., Washington, D. C.

Nobema Products Corporation, New York, N. Y.

Pickett & Eckel, Inc., Chicago, Ill.

Reed Research Inc., Washington, D. C.

Rutherford Machinery Co., Long Island City, N. Y.

Chas. W. Speidel and Co., Inc., Fernwood, Pa.

Trans-Global Company, New York, N. Y.

The Varigraph Company, Inc., Madison, Wis.

Wallace & Tiernan Products, Belleville, N. J.

David White Company, Milwaukee, Wis.

Henry Wild Surveying Instruments Supply Company of America, Inc., Brooklyn, N. Y.

Williams & Heintz Co., Washington, D. C.

Carl Zeiss, Inc., New York, N. Y.


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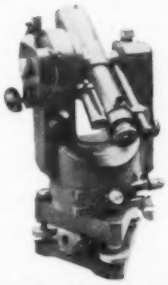

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# Toward Better Land Surveys

*By* JOHN S. HALE
VIRGINIA REGISTERED LAND SURVEYOR AND CIVIL ENGINEER

THE FIELD of property boundary surveying is unique among the fields of applied engineering. Nowhere else is there such a gap between theory and practice as in boundary surveys and the related subject of recordation of property boundaries, as currently practiced in many parts of Eastern United States. Why should there be such a scant body of reliable and permanent data resulting from the vast amount of effort expended over a period of many years? Why is it that, in a field where the most precise instruments and the most refined techniques are available, the most haphazard methods and the most questionable results are not only tolerated but are actually put in permanent record without even a cursory inquiry into their validity? There is the most astonishing gap between what might be done and what is actually practiced. It is interesting to note, for example, in a recent issue of SURVEYING AND MAPPING that a firm of engineers operating in an Eastern city for a period of many years consistently expected and obtained traverse closures better than 1/10,000. Yet, in my district and, I dare say, in most rural and semirural areas in the East, an examination of recorded survey descriptions discloses few with closures better than 1/2,000 and many descriptions without any closure whatever. And when we inquire into the state of recordation of boundary surveys, we find a truly chaotic condition, with no effort made to identify good work, coordinate all work into one system or make the work of the past available for the future. The writer does not claim to be free from this failing; like many others, he has made and recorded surveys that did not represent the best work that he was capable of doing. We do not lack the equipment or the ability to do a good professional job, but we do lack the incentive which must be supplied in part from improved professional standards and higher fee scales; in part from an awakened public demand for better work; and most important, from a legal recognition of good work as distinguished from poor work.

If we are to expect higher fees, we must be prepared to deliver greater values; and this does not mean only a closure of higher precision, but a well-planned procedure to make superior survey results of permanent record, coordinated throughout the area and recognized as valid by the legal profession.

## REASONS FOR POOR SURVEY STANDARDS

The prevailing amount of poor survey work arises from several factors. Most frequently cited, of course, is cost. A recent paper pointed out that it does not greatly increase the cost to raise the accuracy of a survey from 1/5,000 to 1/10,000. But in much country survey work the improvement under consideration is from the order of 1/800 to 1/5,000, which does add a considerable amount to the cost. How frequently we hear the cry, "Sure, I can do a better job, but my client won't pay the extra cost." The solution calls for concerted action among surveyors to raise standards and correspondingly increase fee scales, but it calls for more than that—it requires the education of the public to a realization of the value of superior work and, more important, it demands legal recognition of good work as superior to shoddy work. In my opinion, here is one of the greatest weaknesses of present practice. When a boundary description is recorded, no distinction is made between a good job and a poor job, and the layman cannot tell the difference. Standards now exist and can readily be applied, and it is most important that acceptable work be encouraged, recognized, and permanently recorded,

and that inferior work be branded as such, and barred from the recognition accorded to good work. We should recognize that it is impractical to make it mandatory that survey descriptions of any designated standard of accuracy accompany all land transfers. It does seem practical, however, to give definite legal recognition by registration to surveys of specified accuracy, and to grant registered surveys a legal preferred status in matters pertaining to boundary disputes. It is my aim here to suggest certain procedures to accomplish this result.

There are other factors which tend to keep land survey standards low. We frequently find that attorneys cling to early deed descriptions, inserting those archaic metes and bounds in new instruments of title for reasons of economy, rather than calling for an up-to-date survey. In my experience I have often found a deed referring to perhaps four or five survey descriptions of the various components of the tract, made anywhere from 25 to 50 years ago. It is almost too much to expect to find any two of these descriptions with consistent calls for common lines. Here the remedy lies in convincing the legal profession that good surveys are economical in the long run, and are unquestionably necessary in many instances. If we can develop a procedure whereby all boundary surveys meeting certain standards of accuracy can be registered in an over-all coordinate system, then the results of past work will become available for future transfers without the confusion, discrepancies, and uncertainties which accompany the present practice of reliance upon earlier surveys. We must endeavor to enlist the aid of the legal profession in giving proper legal recognition of good surveys, and in withholding legal approval from inferior surveys. We are apt to find them staunch allies if we can show them that this can be done.

Again, another factor discouraging a more widespread adoption of better survey standards is the variance between acceptable standards for various classes of land. I will be bold enough to state that it is acutely discouraging to a country surveyor to read of survey closures of 1/10,000 as tentative standards for acceptable work—this is not realistic in farm and timberland survey in rough terrain. Without a doubt, transit traverse for control monuments should be maintained to high standards. When we come to the end use, however, which is the establishment and preservation of property corners, it seems illogical to strain for refinements entirely beyond the original concept. For example, we are gratified when we find a roughly squared stone placed years ago to monument a corner—frequently we have a corner marked by a tree or a stump hole; we might set a concrete post with a bronze cap and punch mark to mark this corner, but this "tack point" is obviously straining far beyond the precision of the original corner location and beyond the requirements of the property owner. Under such conditions, while it may give the surveyor some satisfaction to attain a closure of 1/10,000, such a result is not warranted by the original data and has no real meaning or value to his client. If we can fix the position of a farm property corner within 2 feet of its true position, monument it, and record and register the location, we have done all that the situation warrants. It is suggested that the criteria for the end use of a control net for establishment of property boundaries be related to the value and use of the property and the density of control; and that, in the case of large tract boundaries, a position adjustment not to exceed 2 feet be allowed between control points. Under this concept, the expression of error of closure as a fraction is not so important as the actual maximum allowable adjustment expressed in feet. If control were dense, a greater fractional error might be allowable than if control were widespread. Of equal importance, survey specifications should require that all good surveys be related to the coordinate system and should provide for the registration of coordinates of all properly surveyed and monumented corners.

Some Federal specifications do not follow this suggested practice. I recall a Federal specification for boundary survey for acquisition of property in mountainous country in Virginia. No emphasis was placed on the principles of recovery of original corners, but it was specified that all corners be marked by a center punch mark in the top of a steel rod, and that all boundaries be closed to 1/4,000. When one considers that the original surveys were usually compass-and-chain surveys made perhaps a hundred years ago, it is apparent that the recovery of these corners is more an art of retracing the footsteps of the original surveyor, than an exercise in precision measurement of angles and distances. On the other hand, the specifications failed to take into account the value of an over-all control network. All angular values were referenced to a highway centerline location. The highway centerline was continuous for many miles, and the bearings were adjusted every few miles by a Polaris observation. An angular equality was inserted, which combined convergence and accumulated angular errors. Corners, dependent on this base line and computed in plane coordinates for each segment, obviously could have no value as position monuments in a State-wide system. Consequently, although hundreds of permanent markers were set with a rather high degree of precision, they possessed no permanent value for subsequent surveys, simply because they were not placed in the control network. With a rather small additional outlay, they could have been coordinated into the State Plane Coordinate System and could have become supplemental control points of inestimable value for subsequent land surveys. This case illustrates a rather complete reversal from the proper emphasis. In this case, great care was taken to attain high precision in recovering points which were never established as "tack points." On the other hand, the true value of the precision surveys was entirely lost to public use by failure to include the surveys in the legally recognized system of State Plane Coordinates. It might be noted in passing that the cost of these surveys in many instances exceeded the commercial value of the property surveyed.

### A PROGRAM FOR IMPROVEMENT

If we ever expect to bring about a demand from the legal profession and the general public for better surveys, and a willingness to pay the increased costs which necessarily follow, we must demonstrate a better understanding of the objectives sought, and develop within the profession a logical and acceptable procedure to achieve these objectives. I will attempt to state the general objective as follows: Boundary surveys placed on the State Plane Coordinate System, at recognized standards of accuracy consistent with the land use and values, with legal recognition of their worth and permanency by the registration of the plane coordinates of all monumented corners set in accordance with the appropriate standards.

To achieve this objective, the following procedures are suggested. First, the profession must develop standards which not only have technical merit, but also offer definite advantages to the man who is paying the bill. Second, the profession, in cooperation with the legal profession, should develop a program of enabling legislation whereby the coordinates of property corners established in accordance with the standards can be registered in the county courthouse and can derive a superior standing over unregistered corners. Third, to expedite the extension of well-executed surveys, local county authorities should be urged to encourage registration of property corners by some measure of financial aid, such as provision of a corner registry, general supervision through the services of the county surveyor (on a fee paid by the county), and perhaps by furnishing standard monuments for all acceptable surveys.

Let us consider the first procedure, the development of workable standards. A very definite step has been taken in the preparation of technical standards for

land surveys by the American Society of Civil Engineers and the American Congress on Surveying and Mapping. It is submitted, however, that these standards, while technically excellent, do not exhibit much appeal to the landowner, and we do have to "sell" the whole matter to the landowner. I do not advocate any relaxing of standards where such relaxation would build up cumulative errors, as in control networks or in exterior boundaries preparatory to subdivision work.

A clear distinction must be made, however, between control nets, which are a means toward a number of ends; and the particular end use under discussion here, the establishment of property boundaries. Specifications for establishment of control points are well formulated, generally accepted, and need not be discussed here. The particular use which we have in mind is not so exacting as some of the other uses for control points; therefore, we might accept into our system control points which might not be acceptable for all other uses. Specifically, it is my opinion that the control monuments established by the Topographic Division of the U. S. Geological Survey should be included in the State Plane Coordinate nets and should be recognized as source control for certain classes of property boundaries.

When we go into the use of control points in the actual performance of boundary surveys, a different situation arises. Here we are not concerned with a high standard of accuracy to guard against large cumulative errors, but we desire to keep the precision of the final results within bounds consistent with the value and use of the property. Also, we have the added objectives of completing the boundary survey in accordance with the legal aspects of the title, monumenting the corners, and recording a description with the plane coordinates of the corners. If these steps are carried out competently we have achieved a good survey—the standard of accuracy may vary from place to place dependent upon local conditions, but as long as the standards are clearly stated and adhered to, the survey is known for what it is worth.

It seems imperative that survey standards should be divided into two or perhaps three categories: urban and suburban subdivision requiring closures of at least 1/5,000 to 1/10,000, and rural surveys falling perhaps into two classes based on either value of property or proximity to urban area. These latter could properly utilize control which might not be considered suitable for high precision work. It seems a mistake not to utilize fully all control points and to encourage the incorporation of all good survey work into the coordinate system. As stated before, it is considered more important that the criterion be the allowable adjustment of position to place the boundary survey in the control network than to obtain a mathematical closure. It would be most desirable if the specifications could require that all surveys be placed on the plane coordinate system. However, until the density of accurate control points is greater than it is today, this appears to be impractical. Perhaps it would be best to require that, if two control points are each within 5,000 feet of any point on the boundary, the survey should be started and closed at a control point.

In cases where surveys are too distant from control points, it should be required that the survey be made either on true meridian or on grid north for the local plane coordinate system; and that corners be marked by a standard type marker. This would encourage the development of a subsidiary system of boundary monuments, which in time could be incorporated into the State Plane Coordinate System. Here a rather difficult problem arises. It is highly desirable that permanently marked corners set in accordance with proper standards be coordinated, and thenceforth be used to establish positions of other corners. It is recognized, however, that under the standards proposed, there will be some unreconcilable differences; situations would arise where the validity of the earlier survey would be questioned. To resolve this problem,

I would propose that all boundary surveys which, upon critical examination, give position within specified limits be accepted as of equal value. The adjusted values of these corners should be registered in the order of their presentation, and upon registration, the values be accepted as final for that class of survey, and all later surveys of that class of accuracy which tie into them be adjusted to them without further change of the prior position. It is recognized that this is not a strictly correct solution from a theoretical point of view. It is entirely possible that later surveys would give a better determination of position, but from a practical viewpoint, it would be intolerable to have to alter the values of these positions frequently. It is better to register the position of a corner as accurate within certain limits and fixed for all subsequent purposes within that limit. If circumstances later dictate a more accurate position determination, it could be registered in a higher grade registry.

To carry out properly the first step in the program outlined above and to achieve the second step in the proposed program we must seek the legal establishment of registers of the plane coordinate position of properly monumented corners established in accordance with certain standards. We should seek legal advice as to the enabling legislation which would give legal recognition to properly established corners by registration of the plane coordinates, and which would empower local and State governments to take certain steps to foster and encourage the use of corner registration. Provision should also be made for the registration of acceptable surveys, even though not tied into the State Plane Systems, if the survey conforms to the standards and the corners are monumented. Such surveys would have to be registered as "floaters" until such time as later work placed them in the coordinate system. It should be repeated that it is neither wise nor practical to get legislation making it mandatory that surveys conform to certain standards. We already have legislation establishing the permissive use of plane coordinates, but that is not enough. What we should seek now is a legal registration, with county and State authority of positions of recognized accuracy and the acknowledgment that such registration should be established both on a State, county, and municipal level. The State Planning Board or other State-wide engineering bureau should certainly establish the policy that all State-owned lands be placed on the plane coordinate system. They might go further and urge that all Federal land acquisition be placed on the State Plane Coordinate System and the coordinates registered with the State. In some states, notably Connecticut, highway right-of-way surveys have already been placed on the State Plane Coordinate System. Although this will materially increase survey costs, it will prove of inestimable value to the public, and the engineering profession should urge this step for all highway work.

It would seem that the municipal level offers the most ready field for general use of plane coordinates. Most cities have engineering forces equipped and competent to do the requisite high precision work. Model subdivision ordinances recommend the use of State Plane Coordinates. If the city engineering departments would lead the way by establishing a control network and a registry for subdivision corners, it would not be difficult to convert the survey of the city into plane coordinates in a reasonable period of time.

It is at the county level that we find the greatest need and the greatest difficulty in introducing corner registry. Provided that the proper enabling legislation were passed, then the effort must be made to acquaint the county governments with the advantages of corner registration and to persuade them to take the necessary measures to foster and encourage such action. The first step would have to be the establishment of the register to be maintained under the supervision of the county surveyor. Provision would have to be made for the filing of a copy of the original field notes and computations,

preferably on a standard form, duly certified by the surveyor. The county should pay the county surveyor a fee to make a routine check of the computations and to enter the corner position in the register. It would not be practical to provide for a field check of the work, but penalties should be provided for willful falsification of certified field notes. The county should certainly maintain an index map showing the location of registered corners. The county might go a step further and maintain a series of maps on the State Plane Coordinate grid, upon which each certified survey would be entered as it was registered. Many counties in Virginia already possess the nucleus of such a map series in the real property identification maps which they have prepared. The counties might go a step further and encourage the extension of good surveys by furnishing free of charge a standard concrete monument with bronze cap to be set at all property corners which conform to the established standards. This use of public funds could be warranted in view of the undisputed value to the general public of a county-wide system of survey control. It would perhaps be necessary to deputize all certified or licensed land surveyors practicing in the county as deputy county surveyors to make such action legal.

Many advantages would follow from a system of registration of land surveys. Not the least is the positive and ready identification of a tract of land concurrent with the registration of the coordinates of the corners. The writer does not believe that registration of title, as proposed by Professor Morris of Virginia Polytechnic Institute, should be attempted in this procedure. Registration of title involves fundamental legal problems, discussion of which are beyond the scope of this paper. It is the purpose of the proposed program to bring technical survey practice to certain definite and well-known standards of accuracy, and to place such surveys on the plane coordinate system, and to register the coordinates of the corners established where they may be available in further extension of the survey net and may eliminate duplication of effort. The validity of the work as establishing the true boundary will still depend upon the skill and experience of the surveyor and the legal aspects of the situation. In the final analysis this may have to be determined by the courts, but the surveyor can at least state that he knows where he has located the corner, and the lawyers and the courts need not be confused over conflicting claims of technicalities of measurement.

## IMPLEMENTATION OF THE PROGRAM

The above suggestions are submitted to the profession for consideration. There are doubtless many aspects of the problem not touched upon herein, which ought to be brought out. While it is too early to plan a course of action based on the above premises, I will offer a few general suggestions as to how this or a similar program may be implemented. First, the statement of objectives and the program proposed for attaining these objectives should be widely circulated to the surveying profession, to those segments of engineering which deal with surveying problems, to college and university faculties, and to State and Federal agencies interested in survey matters. Every effort should be made to get a representative cross-section of opinion on the subject. If the general reaction favors a statement of objectives and formulation of a program it may then be advisable to appoint a committee representing the American Congress on Surveying and Mapping, the American Society of Civil Engineers, and the National Society of Professional Engineers to draw up a formal statement of objectives and a definite program of action for the endorsement of these organizations. With a program formulated, subcommittees should then be appointed to work out the detailed plans for action along the various avenues of approach to the problem. For instance, it would be essential to have a committee working with representatives of the Bar Associa-

tion on the legal aspects. Another committee should work with the Federal agencies charged with the establishment of control networks. Other committees should work with the governmental agencies on the State, county, and municipal levels to enlist their support of the program. Finally, when agreement has been reached as to just what is to be sought in the way of legislation, every State should have a legislative committee to work for the adoption of the model laws.

In conclusion it should be emphasized that all of the above applies in particular to that part of the Eastern United States where land description is entirely by metes and bounds. It is presumed that in States surveyed by the General Land Office further registry of land corners is neither necessary nor legally permissible.

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## Ethical Surveying Practices

COMPETITION in private practice is perhaps at the root of most infringements of the ethical code, leading to undercutting of fees, attempts to attract clients from a competitor, and probably poor work from a professional standard. These practices have their origin in fear; fear of failure to obtain sufficient work for a living; distrust of one's own capabilities; and fear of the future perhaps largely engendered by the spirit of the troubled times in which we live.

Those who indulge in unethical practices might well consider their conduct from these standpoints; that *competent* surveyors in Australia should have no fear of failure in these times of enormous development and industrial expansion; that their unethical conduct must react on the whole profession and ultimately, therefore, upon their own heads; and that good work in any calling is not done by those who have no confidence in their own powers. As gamblers say, "frightened money wins no bets."

Undercutters might reflect that the legally approved scale of fees is fixed after most careful consideration by a panel of men well fitted to decide upon an equitable scale, and that by undercutting to obtain a temporary and dubious advantage they are attempting to lower the whole standard of the surveying profession in Australia. The recent conference of Empire and U.S.A. surveyors in New Zealand demonstrated beyond all doubt that our standards do not suffer by comparison with any others in the world. Let us, therefore, refrain from pulling down with our own hands such a carefully erected edifice.

If one fears his own capability, it is his duty to rectify it by study and application. The competent man does not fear honest competition.

The public look to the professions for leadership. Surveyors, who are the practitioners of the art upon which our civilization largely rests, should be prepared to take their rightful place in the modern world and by precept and practice demonstrate their ability to do so.

Surveyors have an obligation to their employers, whether they are the general public or Government departments, who, after all, exist for the general good. That obligation implies the giving of their best in every way, but also emphasises that the labourer is worthy of his hire. From an ethical standpoint, therefore, the surveyor should be just as fair to himself in the matter of remuneration, as he is to his clients in the matter of service.

The surveying profession has now an unprecedented opportunity for advancement. Whether advances are made depends entirely on surveyors themselves and on their personal interpretations of ethical practice.—Extract from editorial in *The Australian Surveyor,* March 1951.

# The Responsibilities of a University to the Profession of Surveying and Mapping

*By* N. PAUL HUDSON
DEAN, GRADUATE SCHOOL, OHIO STATE UNIVERSITY

ALTHOUGH I am writing on the topic of the responsibility of a university to the profession of surveying and mapping, I want to make it clear at the outset that that profession is removed from my own career in biology. However, it has been my pleasure over the years, and more recently in my present position as Dean, to observe the growth of science and particularly to become acquainted with the development of such fields as surveying and mapping.

There has been a most remarkable increase in scientific knowledge, both through research by curious persons and through demands by responsible officials for application of new knowledge to problems of scientific and public interest. With this growth through research and application, there has been a concurrent demand for basic and advanced education.

Also associated with the growth of a science is the development of interrelationships among the sciences. I know of no subject that can stand by itself. Active fields are related one with another at both the fundamental and the advanced levels. Contrary to supposition by the uninitiated, the most advanced research involves association with other fields of interest in theory as well as in technique.

It is interesting to note that when a field becomes sufficiently distinctive, it aspires to be recognized as a profession. The definition of a profession is difficult, but it certainly includes these elements: an identifiable body of knowledge, a spirit of public service, a code of honor and respectability, and an organization of persons and activities having such qualities.

And so a profession grows to the point of being recognized, and an essential part of that growth and recognition is emphasis on education and research.

I understand that the field of surveying and mapping is emerging as a profession. Not only has it developed because of growth through scientific advance, but it has been encouraged by demands for precise measurements of the earth and its surface. Research and education are factors in such developments, and I assume that education is not only in the techniques of the field but more importantly in theories and principles. Such education is obviously based on broad foundations, extends into related fields, and is intensified by training in research. Added to this, I assume that there is developing the spirit of a profession.

If this description of the status of surveying and mapping and these suppositions are correct, then I think I have been describing educational and research circumstances offered by a university.

In relation to the profession of surveying and mapping, I should like to describe the establishment of the Institute of Geodesy, Photogrammetry and Cartography at The Ohio State University. By an "institute," we mean a voluntary association of faculty members interested in a common educational and research program. The distinctive feature of an institute is that this responsibility is carried out in relation to instruction and research, without respect to the academic location of courses or facilities; it is the commonness of purpose and interest that characterizes an institute. Through such a device interrelationships at all levels of instruction and association of research wherever undertaken in the university are fostered and encouraged. And finally, the organization thus developed is an authority on the subject in the university and for outside agencies.

These, then, are the principles we asso-

ciate with an "institute," such as the Institute of Geodesy, Photogrammetry and Cartography, which functionally is responsible to the Dean and Graduate Council of the Graduate School, and thence to the University Administration. We feel that a university of our type provides staff and physical facilities for the development of these subjects. We are able to furnish basic education in these and related fields. Graduate instruction to the doctoral degree is offered in physics, astronomy, mathematics, geology, civil engineering, geography, chemistry, electrical engineering, and supporting subjects. Assembled on the one campus are faculty members, specialized equipment, and library resources which provide at least a beginning and which will be augmented with time. But more important than all else is that on the University campus there is an atmosphere of investigation and of professional ideals.

In addition to the facilities provided by a University of our kind, there was another factor which led to the establishment of the Institute at The Ohio State University. We have, under the aegis of the Research Foundation, the Mapping and Charting Laboratory which is engaged in research on gravity, aspect of guided missiles, and precision measurements of long distances and directions. Included in the personnel of this Laboratory are faculty members whose primary appointments are in various departments of instruction (Professors Harding, Heiskanen, Bobrovnikoff, Hynek, Slettebak, Dickey, and Shaw, representing Civil Engineering, Geology, Astronomy and Physics). They saw, with you and me, that advances in your fields are best promoted by education at the undergraduate and graduate levels, associated with research. Their activities in the Laboratory and constant association with the faculty and research of related areas provided an academic situation which naturally led to the establishment of the Institute. Other qualified specialists, not now on the faculty but active in the Mapping and Charting Laboratory, will be available in a limited way for assistance in teaching and, through approved courtesy appointments to the faculty, will contribute to the academic activities of the Institute.

Now allow me to describe briefly the composition of the Institute of Geodesy, Photogrammetry and Cartography. As I have said, it is in the Graduate School, but it has to do with establishing and supervising curricula at the undergraduate level as well. Its administration is in the hands of an administrative board whose members are a Scientific Director, Executive Director, Deans of the Graduate School and the College of Arts and Sciences, and two faculty members. There are four faculty committees: research and publications, curriculum, professional development program, and space and equipment. In addition, there is to be established an advisory committee, which is to include experts in outside agencies interested in these subjects.

As I have stated, the educational program is to be both undergraduate and graduate, the latter being either departmental or interdepartmental, according to the specific interests and the capacities of the individual student. Undergraduate work in specific and related courses, wherever undertaken in the University, will lead to the Bachelor of Science degree. Graduate work, including training in research, leads to the Master of Science and the Doctor of Philosophy degrees.

Faculty research as now conducted will continue and will be augmented under the influence of the Institute. Much of it will be interdepartmental, in an atmosphere conducive to easy relationships.

The fields of surveying and mapping and of geodesy, photogrammetry and cartography, in our terms, are splendid examples of sciences growing and developing through research and public demands. Universities, with their varied personal and physical facilities, their diverse subjects of study and research, and their atmosphere of education and investigation are responsible as public servants to pro-

mote fields of study and research in the interest of science and the public.

The Ohio State University in recognition of this responsibility has undertaken to strengthen its offerings and activities in the studies of the earth and its surface.

We anticipate through its resources and the assistance of interested agencies elsewhere that the University will be able to contribute to the fundamental and professional development of surveying and mapping through its establishment of the Institute of Geodesy, Photogrammetry and Cartography.

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## Geodetic Survey Links Antilles Islands

ONE OF THE MOST SIGNIFICANT survey operations in the history of the Caribbean Archipelago was successfully completed recently when engineers of the Inter-American Geodetic Survey, working in collaboration with cartographic agencies of three nations, established a first-order triangulation network linking Cuba, Haiti, and Jamaica. Working under the supervision of the Officer in Charge, Major J. Newton Cox, Corps of Engineers, U. S. Army, eighteen American engineers, stationed on strategically located mountain tops in the three countries, set up their surveying instruments and signal lights, and in five weeks accomplished a job which was originally estimated to take six months. Some eminent geodesists even said that the job was impossible, for the lines of sight to be observed were extremely long.

However, by utilizing 500-watt ship searchlights, most stations proved to be intervisible. The longest line of sight between two triangulation stations that had previously been recorded was 190 miles. From station Pico Turquino in Southeastern Cuba to station Macaya in the western tip of Haiti is an airline distance of 214½ miles. This was too much for the 500-watt searchlights; neither station could see the other. So a rush call went out for several 1000-watt aircraft beacons, which, when modified with special mountings and reflectors, made effective contact between the two points.

The international scope of the Antilles Tie, as the operation was called, presented many problems. Each participating nation spoke a different language; each has its own concept of surveying procedures. It is a tribute to the collaborative spirit of each country that the execution of the project went so smoothly. Lightkeepers, packers, even trained technical personnel were made available to the project by the cartographic agencies of each nation. Problems of logistics and supply were expedited, and in the words of one of the engineers, "I've never seen such cooperation. Those people assisted us in every way possible."

Much of the equipment used in the operation had to be designed or modified for maximum portability, for all supplies, equipment, and instruments were carried to the tops of mountains by packers or mules. One station in Cuba was supplied by helicopter, after a group of men had walked for twenty hours to reach the station in order to clear it for helicopter landings.

The purpose of the Antilles Tie is to connect the triangulation networks of Jamaica and Haiti with the established North American datum which has been extended to Cuba. As part of the gigantic mapping and charting program now in progress throughout the Western Hemisphere, it is expected that this triangulation will be carried on down through the islands of the Caribbean Archipelago until it is connected into the South American datum, thereby creating an accurate framework upon which future maps of this area will be based.

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**MEMBERS PLEASE NOTE NEW DATE FOR ANNUAL MEETING**
**MARCH 23–25, 1953, WASHINGTON, D. C.**

# La Cartografía en Mexico

*By* BRIGADIER-GENERAL MIGUEL SANCHEZ A. LAMEGO
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(*English translation by Francis J. Ortiz, U. S. Coast and Geodetic Survey.*)

IT CANNOT be denied that, since ancient times, man has consistently pretended to leave to his contemporaries and to posterity a knowledge of his geographic surroundings; that is, it has been his desire to leave a written record of the countries he knew, using sometimes descriptive narratives and at other times graphic representation. So it is that more or less detailed geographic narrations—some of them truly fantastic—have been found among even the less civilized peoples of very remote eras, as well as graphic documents made on various materials, on which attempts were made to portray unknown territories or the itinerary followed by the author during his travels.

In this respect it may be well to recall that the oldest cartographic "tablets" known were found among the ruins of wealthy Babylon, and they are today preserved in the British Museum and are believed to date from the year 3800 B. C. As for our own aboriginal race, the chroniclers of the time of the Conquest state that Hernan Cortes observed, in the hands of Emperor Montezuma II, a map of the Gulf of Mexico, which showed that even at that time some cadastral maps of cities in the Aztec Empire existed among the Indians.

Now, if the need for maps was felt even in those remote times when there was no scientific basis for their production, the demand became more and more pronounced, during the years that followed the conquest by the Spaniards, to the extent that in the present century it as-

ES INCONCUSO, que desde los tiempos más lejanos, el hombre ha pretendido dejar a sus contemporáneos y a la posteridad constancia de sus conocimientos geográficos, es decir, ha querido dejar un recuerdo escrito de los países que conoció valiéndose para ello, unas veces de las narraciones descriptivas y otras, de las representaciones gráficas. Es así como se han encontrado, aún entre los pueblos menos civilizados y pertenecientes a épocas muy remotas, narraciones geográficas más o menos detalladas, algunas de ellas verdaderamente fantásticas, así como documentos gráficos hechos sobre materiales diversos, en los cuales quedaron representados los territorios que se trataba de hacer conocer o los itinerarios seguidos por el autor, en el curso de sus viajes.

A este respecto conviene recordar, que las "tablas" cartográficas más antiguas de que se tiene noticia, fueron las halladas en las ruinas de la opulenta Babilonia, las cuales se conservan todavía en el Museo Británico, creyéndose que datan del año 3,800 antes de nuestra era y, que, por lo que se refiere a nuestras razas aborígenes, los cronistas de la época de la Conquista afirman que el conquistador Hernán Cortés pudo contemplar, en manos del Emperador Moctezuma II, un mapa del Golfo de México y que en aquel entonces ya existían entre los indios, algunos mapas catastrales de ciudades del imperio azteca.

Ahora bien, si en aquellos lejanos tiempos, la necesidad de la existencia de los mapas se hizo sentir, hasta el grado de producirlos sin ninguna base científica, en los años que siguieron a la conquista por los españoles, esa exigencia se fué acentuando más y más, hasta el grado de

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sumed an imperative character, for knowledge of the national territory now has various aspects of vital importance. I believe that cartography today not only fulfills its descriptive function but assumes a very important role in social activities, not only from an educational and political point of view, but also economical and military. It is logical to believe that the resulting benefits obtained from these functions will depend particularly on the quality of the maps—that is to say, their true representation of the terrain, or better yet, their accuracy and precision.

In effect, one can assume that a child, during the course of his primary education, makes his first contact with his fatherland by means of maps, and so learns the territorial extent of his country, its geographic position, its boundaries, its political subdivisions, the physiographical regions that compose it, the principal products of each region, the location of its principal demographic centers, etc. Later, if the individual continues his secondary and preparatory studies, it will also be through cartography that he will come to know the Republic much better, with all its economic attributes; that is, he will know the location of the most productive mining centers, the rich agricultural regions, the various lines of communication which bind them together, the distribution of population, the importance of commerce, etc. Besides, he will also become acquainted, even if only in a general way, with the other countries of the globe; he will be able to judge then the relative importance that his country occupies, not only on the American Continent, but in the world.

Moreover, through his studies he will also become acquainted with the principal historic events that determined the different stages of the political progress of the nation and, as by then he will have formed a definite concept of his country, he will be able to relate perfectly the na-

que, en el siglo actual, puede decirse que tiene un carácter imperativo, pues el conocimiento del territorio nacional tiene ya variados aspectos de importancia vital. Es que, en los días que corren, considero que la Cartografía, además de llenar esa función descriptiva, desempeña funciones sociales mucho muy importantes, tanto desde los puntos de vista educativos y políticos, como económicos y militares; en concepto, que es muy lógico pensar, que la bondad de los resultados que se obtengan por la acción de estas funciones, dependerá muy particularmente de la calidad de los mapas, es decir, de la veracidad de éstos o mejor aún, de su exactitud y precisión.

En efecto, se supone que es por medio de los mapas como el niño, en el curso de su educación primaria, toma el primer contacto con la patria, representada por el extenso territorio que la forma y con ellos se enseña a conocer su extensión, su posición geográfica, sus límites, su división política, las provincias fisiográficas que comprende, los principales productos de cada región, la ubicación de sus principales centros demográficos, etc. Todavía después, si el individuo continúa sus estudios secundarios y preparatorios, será también por medio de la Cartografía como vendrá a conocer mucho mejor a la República, contodos sus atributos económicos; es decir, conocerá la localización de los centros mineros más productores, las ricas regiones agrícolas, las diversas vías de comunicación que las ligan, la distribución de la población, la importancia del comercio, etc., y como además conocerá también, aun cuando sólo sea a grandes rasgos, a los demás países del Globo, podrá juzgar entonces la importancia relativa que tiene nuestra patria, tanto en el continente americano, como en el mundo entero.

Por otra parte, por sus estudios conocerá también los principales acontecimientos históricos que han determinado las diferentes etapas del progreso político de la nación y como ya para entonces tendrá formado un concepto definido de su patria, podrá relacionar perfectamente el

tional geographic medium and the human or racial factor so that he will develop in his mind a worship for its national heroes, a love for his country, and a respect for the laws that govern it. The basis of the political organization of the Mexican people, like the other countries of the world, is only the result of the influence, more or less preponderant, of the geographic factor on the psychology of the human element.

The economic functions of cartography are also of major importance to the progress of the nation, for it will be with the aid of maps that a rational and logical study of the value and impetus of the economic factor can be determined, in accordance with the zones or regions of production. That is why, for example, with the help of topographic maps, the mineral, forest, and agricultural resources of the nation can be investigated. With maps the general outline of the lines of communication necessary for the development of these natural resources can be planned with relative ease and at relatively little cost, and a better demographic distribution can be planned from the point of view of exploitation, in accordance with the locations of these same resources. Finally, with respect to my country, it can be said, that with the aid of a good map it will be possible to evaluate the magnitude of the existing forest reserves in the States of Durango, Chihuahua, Michoacán, and Guerrero; as well as the riches of the productive agricultural regions of Bajío and Laguna; the importance of the petroleum regions of Huasteca, Minatitlán, and Tabasco; the agricultural and industrial possibilities of the basins of the Papaloapan and Tepalcatepec Rivers; the industrial wealth of sisal in the Yucatan Peninsula; the possible development of other cotton markets similar to the one at Matamoros; also, the extensive coffee plantations of Chiapas, bananas in Tabasco, sugar cane in Morales, and tobacco and vanilla in Veracruz—and to try to obtain with all

medio geográfico nacional con el factor humano ó racial, con lo que se desarrollará en su espíritu el culto a los héroes nacionales, el amor a la patria y el respeto a las instituciones que la rigen. Es que, las bases de la organización política del pueblo mexicano, al igual que las de las otras naciones del mundo, no son sino el resultado de la influencia más o menos preponderante del factor geográfico, sobre la psicología del elemento humano.

En lo que se refiere a la función económica de la cartografía, ésta es también de capital importancia para el progreso de la nación, pues será con ayuda de los mapas como podrá hacerse un estudio racional y lógico del valor e impulso del factor económico, de acuerdo con las zonas ó regiones de la producción. Así, por ejemplo, será con ayuda de las cartas topográficas como podrán investigarse los recursos minerales, forestales y agrícolas de la nación; como se podrá proyectar con relativa facilidad y a poco costo, el trazo general de las vías de comunicación necesarias para la explotación de esos recursos naturales y como se podrá planear, desde el punto de vista de la explotación, una mejor distribución demográfica, de acuerdo con la ubicación de esos mismos recursos. En resumen y concretando la cuestión para mi país, puede decirse, que con la ayuda de un buen mapa, se podrá valorar la magnitud de las reservas forestales existentes en los Estados de Durango, Chihuahua, Michoacán y Guerrero; el valor agrícola de las productivas regiones del Bajío y de la Laguna; la importancia de las zonas petroleras de la Huasteca, de Minatitlán y de Tabasco; las posibilidades agrícolas e industriales de las cuencas de los rios Papaloapan y Tepalcatepec; la riqueza industrial henequenera de la Península Yucateca; el posible desarrollo de otros emporios algodoneros como el de Matamoros, así como el de los extensos plantíos de café en Chiapas, de plátano en Tabasco, de caña de azucar en Morelos y de tabaco y vainilla en Veracruz, para llegar a obtener con todo ello, una coordinación perfecta

this a perfect coordination between the geographic factor and human economic activities.

For us, the military, cartography is also of the utmost importance, since by means of it we are able to know the terrain where a specific action of war is going to take place. With the aid of maps a commanding officer of troops can take into account not only the topographic and hydrographic characteristics of the region in which he finds himself operating, but also the class of products he can expect to find in the area, the nature of the soil, and the advantages or disadvantages of its topographic features. The ground is the scene of all military operations and it is obvious that the better that terrain is known, the better one can make use of its natural advantages. It is to be noted, in this respect, that the systematic use of maps in war can be said to have been initiated during the middle of the 18th century, when Frederick the Great created a corps of geographers and topographers in his army, during the so-called "Seven Years' War", and that a half century later the "Great Corsican" reaffirmed this practice by planning his brilliant campaigns on maps. Now if, in those days when the field of battle could be covered with one glance, the use for good maps was already considered indispensable, what can be said of the present day when the field of battle has expanded to an extraordinary degree? The answer to this question is obvious—indeed, maps have been recognized as an absolute necessity, since they enlarge the visual perspective of the commander-in-chief, allowing him to plan over areas located far beyond his line of vision.

If now we examine this matter from a higher plane, we can see that, with the aid of maps, the Chiefs of Staff can determine the various theaters of possible operations, noting in detail all their particular characteristics, and plan with sufficient dili-

entre el factor geográfico y las actividades económicas humanas.

Para nosotros los militares, la Cartografía es también de suma importancia, ya que por medio de ella podremos conocer el terreno donde va a tener lugar una acción de armas determinada y al decir conocer el terreno, esto quiere significar que con ayuda de los mapas, un Comandante de Tropas podrá darse cuenta, no sólo de las características oro e hidrográficas de la región en donde se halle operando, sino también de la clase de productos que puede esperar recoger en ese terreno, de la naturaleza del suelo y de las ventajas o desventajas de sus formas topográficas. El terreno es el escenario obligado de toda operación militar y es claro, que mientras mejor pueda conocerse ese escenario, mejor podrán aprovecharse sus ventajas naturales. Recuérdese a este respecto, que el uso sistemático de los mapas en la guerra, puede decirse que se inició a mediados del siglo XVIII, cuando Federico el Grande creó un Cuerpo de Geógrafos y Topógrafos en su Ejército, durante la llamada "Guerra de los Siete Años" y que medio siglo más tarde, el "Gran Corso" reafirmó esa práctica, planeando sobre la carta sus maravillosas campañas. ¿Y bien, si en aquellos tiempos, cuando el campo de batalla podía abarcarse con la mirada, la existencia de buenos mapas era ya considerada como indispensable Qué podrá decirse pra los días que corren, en que los campos de batalla se han ensanchado en forma completamente extraordinaria? La respuesta a esta pregunta es obvia, ya que la existencia de las cartas es de absoluta necesidad, puesto que ellas ensancharán la perspectiva visual del Comandante en Jefe, permitiéndole decidir sobre zonas situadas mucho más allá de donde alcanza su visión.

Si ahora se examinara este asunto desde un plano más elevado, podría verse, que con auxilio de los mapas, el Estado Mayor General podrá determinar los diferentes teatros de operaciones posibles, anotando y detallando todas sus características par-

gence the difficult problem of national defense—a task that includes the study of the total mobilization of the country, with all its human, agricultural, industrial, and commercial resources, etc.

It is appropriate to say here that my country has always lacked good cartography, and that I deem this circumstance combined with the enormous extent of the territory, the low density of population, the physiographical conditions, and the lack of good lines of communications has contributed to the development of many of the revolts that occurred, particularly during the first two-thirds of the last century. In effect, as I see it, I believe that the rebel leaders, by having a good knowledge of the terrain in which they operated, considered themselves safe from any rapid extermination, basing their belief on the transportation difficulties to be encountered across our rugged sierras and, above all, the lack of adequate maps that could guide the enemy troops.

Inasmuch as the preparation of maps is of the utmost urgency, and since it is most apropos for the military to perform the field work of topographic surveys, the Mexican Army, as in many other American and European countries, had to take upon itself this task. Since the colonial epoch this type of work was started with the execution of various "travel guides" and "route charts" which, although somewhat generalized, nevertheless gave the general characteristics of a given road; that is, its total length, travel difficulties, the importance of the towns passed, etc. One of these "travel guides" that could serve as a typical model of this kind of military work, is the one prepared by the Spanish Chief of Engineers, Manuel de Santiesteban about the year 1769, in connection with the two roads that led to the Port of Veracruz—one through the towns of Perote and Jalapa and the other through those of Orizaba and Córdoba.

ticulares y planear con bastante acuciosidad, el difícil problema de la defensa nacional, tarea que incluiría el estudio de la movilización general del país con todos sus recursos humanos, agrícolas, industriales, comerciales, etc.

Cabe decir aquí, que en mi país se ha carecido siempre de una buena Cartografía y que considero, que esta circunstancia, aunada con la enorme extensión del territorio, la baja densidad de la población, las condiciones fisiográficas y la carencia de buenas vías de comunicación, fueron hechos que facilitaron la producción y el desarrollo de muchas de las revueltas ocurridas, muy particularmente en el transcurso de los dos primeros tercios del siglo pasado. En efecto, según mi modo de ver las cosas, creo que los cabecillas rebeldes, siendo buenos conocedores del terreno de la región en que actuaban, se consideraban al abrigo de un rápido exterminio, apoyando su creencia en las dificultades del tránsito a través de nuestras abruptas serranías y, sobre todo, en la falta de buenos mapas que pudieran guiar a las tropas enemigas.

Siendo pues imperiosa la elaboración de los mapas y siendo los militares, los individuos màs a propósito para llevar a cabo los trabajos de campo de los levantamientos topográficos, el Ejército Mexicano, al igual que lo ocurrido en otras naciones americanas y europeas, tuvo que evocarse esa tarea y así, podrá verse que desde la época colonial se inició esta clase de trabajos, con la ejecución de diversos "itinerarios" y "derroteros" que hicieron conocer, aunque fuese a grandes rasgos, las características de un camino dado; es decir, su longitud total, las dificultades de su tránsito, la importancia de los poblados que tocaba, etc. Uno de esos "itinerarios", que podría servir como modelo de esta clase de trabajos militares, puede ser el que elaboró el Brigadier de Ingenieros Español Manuel de Santiesteban, hacia el año de 1769, en relación con los dos caminos que conducían al Puerto de Veracruz, uno por las Villas de Perote y Jalapa y el otro por las de Orizaba y Córdoba.

Subsequently, during the course of our independent life, topographic surveys of some of the National States or Departments were attempted, particularly of the Federal District; but the turbulence of Mexican life in the first half of the past century prevented the complete realization of these efforts. The introduction of geodesy gave a great impetus to cartography, and with the aid of this science, the first series of harbor charts of the Republic was made in the year 1850, completed by a military group under the direction of General Pedro García Conde.

As the years passed and there was only a vague idea of what the national territory consisted of, and since a good map at a convenient scale that would show the important topographic details of the terrain was lacking, General Porfirio Díaz, then President of the Republic, decided to tackle the problem with determination, and in 1877 he created the so-called "Geographic Exploration Commission," placing at the head of it a military man, Col. Agustín Díaz, Corps of Engineers.

This organization was given the task of preparing a general map of the territory of Mexico, at the scale of 1: 100,000, and thanks to the sound efforts of Col. Díaz, during the 37 years it operated, and in spite of the slowness with which the work proceeded because of topographic difficulties, it succeeded in publishing 458 sheets covering an area of approximately 970,000 square kilometers; that is, almost half of the total area of the Mexican territory.

In August 1914, as a consequence of the victory of the constitutional revolution and the dissolution of the Federal Army, the "Geographic Exploration Commission" ceased to exist, and all the instrumental equipment was placed under the "Dirección de Geografía" under the Secretaría de Agricultura y Fomento, where, during the years that followed, work on the 1: 100,000 scale maps was

Posteriormente, ya en el curso de nuestra vida independiente, se intentaron los levantamientos topográficos de algunos de los Estados ó Departamentos nacionales, muy particularmente el del Distrito Federal, pero la turbulencia de la vida mexicana en la primera mitad del siglo pasado, impidió la realización completa de estos trabajos. Vino después el conocimiento de la Geodesia y con ello, la Cartografía sufrió un buen impulso, pues con ayuda de esta ciencia, se logró formar el primer portulano de la República, hacia el año de 1850, cosa llevada a cabo por una comisión formada por militares y presidida por otro militar, el General Pedro García Conde.

Como pasaron los años y no se tenía más que una idea imprecisa de lo que era efectivamente el territorio patrio, ya que no se contaba con una buena carta, a escala conveniente, que hiciera conocer los detalles importantes del terreno, el General Porfirio Díaz, Presidente de la República en funciones, decidió abordar con resolución el problema y el año de 1877 creó la llamada "Comisión Geográfica-Exploradora" y puso al frente de ella también a un militar, el Coronel de Ingenieros Augustín Díaz.

La misión dada a este organismo, fué la de hacer una carta general del Territorio mexicano a la escala de un cienmilésimo y gracias a la atinada labor desarrollada por el Coronel Díaz, en los 37 años que funcionó, a pesar de la lentitud obligada del trabajo debida a los procedimientos de la topografía terrestre, consiguó la publicación de 458 hojas, que representan una superficie aproximada de 970,000 kilómetros cuadrados, es decir, casi la mitad de la superficie total del territorio mexicano.

En agosto de 1914, a consecuencia del triunfo de la revolución constitucionalista y del licenciamiento del Ejército Federal, la "Comisión Geográfica Exploradora" dejó de existir, pasando todo el acervo instrumental a depender de la Dirección de Geografía, perteneciente a la Secretaría de Agricultura y Fomento, donde en

suspended owing, above all, to the lack of adequate appropriations; nevertheless, it must be said, that other maps at a scale smaller than 1:100,000 were produced, which covered the entire Republic; but it must be made clear that these publications were not based on well-planned and consistent surveys.

In 1938, as a consequence of the government's desire to establish accurately the boundary between Mexico and the Republic of Guatemala, the agency called "Comisión Geográfica Militar", comprising mostly military personnel, was created under the Secretary of National Defense to take charge of this task. This organization subsequently received the name of "Servicio Geográfico del Ejército", and at the present time carries the name of "Comisión Cartográfica Militar", a name more in keeping with its specific activities.

Soon after the "Comisión Geográfica Militar" had begun to function, World War II broke out, and then the North American government decided to construct the World Aeronautical Chart at the scale of 1:1,000,000, based on aerial photographs. Inasmuch as Mexico took part in that struggle on the side of the free nations, through agreements made by the two nations, the United States government forwarded to my country a copy of each and every photograph taken of the Mexican Territory. Relying on this material as a base, and taking into account the great advantages of aerial photogrammetry, the task of making the general chart of the Republic at the scale of 1:100,000 was again attacked, in order to fulfill the functions previously referred to. Moreover, the possibilities in this work having been seen, the preparation of the chart of the Valley of Mexico at the scale of 1:25,000 was subsequently undertaken.

It is well to bear in mind the fact that Mexican cartography cannot be separated

los años que siguieron los trabajos de la carta a la cienmilésima quedaron estancados, debido, antes que todo, a la falta de presupuestos adecuados; sin embargo, es de mencionarse, que se produjeron otros mapas a escalas menores que la cienmilésima, los cuales abarcaron la totalidad de la República; pero conviene aclarar que estas publicaciones no provinieron de levantamientos serios y consistentes.

Hacia 1938 y a consecuencia del deseo gubernamental de fijar con cierta exactitud los límites entre México y la República de Guatemala, se creó bajo la dependencia de la Secretaría de la Defensa Nacional, la llamada "Comisión Geográfica Militar" para que se encargara de los trabajos relativos, siendo formada en gran parte por personal militar. Este organismo posteriormente recibió el nombre de "Servicio Geográfico del Ejército" y actualmente lleva el de "Comisión Cartográfica Militar", designación más acorde con su función específica. Al poco tiempo de haber comenzado a funcionar la "Comisión Geográfica Militar", sobrevino la Segunda Guerra Mundial y entonces, el gobierno norteamericano decidió la elaboración de la Carta Aérea Continental a la escala de un millionésimo y a base de fotografías aéreas; como México tomó parte en aquella contienda al lado de las naciones libres, debido a convenios formulados entre ambas naciones, el gobierno estadounidense hizo entrega al de mi país, de una copia de todas y cada una de las fotografías tomadas en territorio mexicano. Contándose con este material de base y tomando en cuenta las grandes ventajas del procedimiento aerofotogramétrico, nuevamente se abordó la tarea de formar la carta general de la República a la escala de un cienmilésimo, para satisfacer las funciones a que me he referido en la primera parte de este trabajo. Además, vistas las posibilidades de trabajo, se abordó posteriormente la elaboración de la carta del Valle de México a la escala de 1:25,000.

Es de advertir, que tomando en consideración el hecho de que la Cartografía

from the continental cartography, for Mexico is a member of the Pan American Institute of Geography and History, and therefore, the "Comisión Cartográfica Militar" endeavored to follow the same methods and procedures as the North Americans, whose mapping and charting organizations, because of their experience and methods, can be considered the best on the continent. Because of this, the Trimetrogon method was continued in use, not only in taking the photographs but also in their restitution. The Transverse Mercator Projection and its corresponding military grid were adopted, and all related symbols, typography, and the general format of the sheets have been taken almost in their entirety from the North American charts. I want to make clear that the United States Government has greatly assisted the cartographic work in my country, and thanks to that, numerous Mexican personnel have received training at various North American cartographic organizations, such as the Coast and Geodetic Survey and the Army Map Service, in order to acquire practical knowledge in the various phases of cartographic work.

Thanks to all these circumstances, in 1950 the "Comisión Cartográfica Militar" started publishing the first sheets of the General Map of the Republic, at the scale of 1: 100,000, and in 1951, the sheets of the map of the Valley of Mexico, at the scale of 1: 25,000, of which to date 16 sheets have been printed. The average production is one sheet a month, which will surely be increased as our personnel acquires the necessary experience and skill.

I would like to call attention to the fact that these maps that we are making fulfill perfectly the requirements to which I referred originally, since they contain all the useful data not only to comply with educational and political requirements, but also the economical and military.

Mexicana no podía desligarse de la Cartografía continental por pertenecer México al Instituto Panamericano de Geografía e Historia, la "Comisión Cartográfica Militar" procuró seguir los mismos métodos y procedimientos que los norteamericanos, cuyas organizaciones relativas, por su experiencia y medios puestos en juego, resultan ser los mejores de todo el Continente. Es por esto, que se continuó usando el método llamado "Trimetrogón", no sólo para la toma de las fotografías, sino también para su restitución, y se ha adoptado la Proyección Transversal de Mercator y la Cuadrícula militar correspondiente; asimismo, todo lo relacionado con símbolos, tipo de letras y formato en general de las hojas, ha sido tomado, casi en absoluto, de las cartas norteamericanas. Es de aclarar, que el gobierno de los Estados Unidos ha dado un gran apoyo a los trabajos cartográficos de mi país y que gracias a ello, mucho personal mexicano has pasado a las organizaciones cartográficas norteamericanas, como el Coast and Geodetic Survey y el Army Map Service, para adquirir habilidad en las diversas fases del trabajo cartográfico.

Gracias a todas estas circunstancias, apenas a partir del pasado año de 1950 la "Comisión Cartográfica Miiltar" ha comenzado la publicación de las primeras hojas de la Carta General de la República a la escala de un cienmilésimo y a partir del actual, de las hojas de la carta del Valle de México a la escala de 1: 25,000, contándose a la fecha con solo 16 hojas impresas, pues la producción media mensual es de una hoja, rendimiento que seguramente será mejorado a paso y medida que el personal adquiera experiencia y habilidad.

Quiero hacer notar, que estas cartas que se están elaborando, pueden perfectamente satisfacer las funciones a que hice referencia en un principio, pues llevan consigo todos los datos que pueden ser útiles, tanto para llenar las exigencias educativas y políticas, como las económicas y las militares, de suerte que

These maps can be considered not only as a contribution by the Mexican Army to national prosperity but also as a tribute to international cooperation in our search for a better understanding of the world in which we live.

deben ser consideradas, no sólo como una labor del Ejército Mexicano para contribuir a la prosperidad nacional, sino también como un tributo a la cooperación internacional, en busca de un mejor conocimiento del mundo en que vivimos.

▼ ▼ ▼

# If

(With apologies to Rudyard Kipling)

*If you can swing an axe, or wield a brush hook,*
*Or drive a stake, or drag a chain all day,*
*If you can scribble "figgers" in a notebook,*
*Or shoot a range pole half a mile away,*
*If you can sight a transit or a level,*
*Or move a target up and down a rod,*
*If you fear neither man, nor ghost, nor devil,*
*And know yourself and trust the living God.*

*If you can wade a swamp, or swim a river,*
*Nor fear the deeps, nor yet the dizzy heights,*
*If you can stand the cold without a shiver,*
*And take the Higgins' ink to bed o'nights,*
*If you can turn a thumbscrew with your fingers,*
*When every digit's like a frozen thumb,*
*If you can work as long as daylight lingers,*
*And not complain, nor think you're going some.*

*If you can sight through tropic heat's refraction,*
*Or toil all day beneath a blistering sun,*
*If you can find a sort of satisfaction,*
*In knowing that you've got a job well done,*
*If you can be an Eskimo and nigger,*
*And try to be a gentleman to boot,*
*If you can use a "guessin' stick" to figger,*
*And know a coefficient from a root.*

*If your calculus and descriptive are forgotten,*
*And your algebra just serves you fairly well,*
*And your drafting and your lettering are rotten,*
*And your Trautwine's always handy by to tell,*
*If you can close a traverse without fudgin',*
*Or check a line of levels by a foot,*
*If you can set a slope stake just by judgin',*
*And never kick a tripod with your foot.*

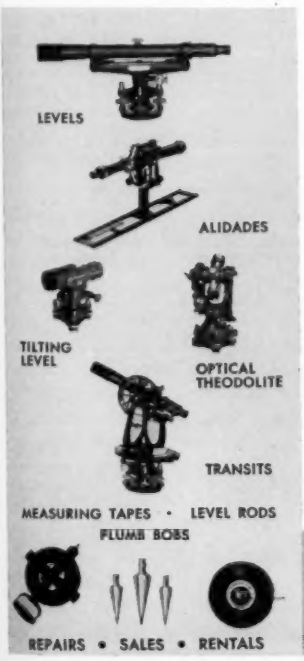
*If you can run a line where you are told to,*
*And make it stay somewhere on the map,*

*If you can read your notes when they get cold, too,*
*And know that contours mustn't overlap,*
*If you can line a truss or tap a rivet,*
*Or make a surly foreman come across,*
*If you can take an order, well as give it,*
*And not have secret pity for the boss.*

*If you can climb a stool and not feel lowly,*
*Nor have your head turned by a swivel chair,*
*If you can always reach your judgments slowly,*
*And make your rulings always just and fair.*
*If you can give yourself and all that's in you,*
*And make the others give their own best, too,*
*If you can handle men of brawn and sinew,*
*And like the men and make them like you, too.*

*If you can't boast a college education,*
*Or, if you've got a sheepskin, can forget,*
*If you get a livin' wage for compensation,*
*And give a little more than what you get,*
*If you can meet with triumph and disaster,*
*And treat them without favor, nor with fear,*
*You'll be a man and your own master,*
*But—what is more—you'll be an ENGINEER.*

—Robert I. Randolph

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# Nomenclature for Base Twelve Numbers

*By* PAUL VAN BUSKIRK
THE HURON-CLINTON METROPOLITAN AUTHORITY

SIMON STEVINUS, originator of decimal fractions, also advocated the replacement of the decimal system by the duodecimal, as set forth on page 6 of his *L'Arithmetique*, Leiden, 1585.

It is unfortunate that his suggestion was not followed, for it was not until well after our dollar coinage was begun in 1794 that the ordinary man was able to comprehend or use decimal fractions. The 12-part fractions would have been quickly accepted, as all European systems of weights and measures had borrowed from the original Roman 12-part or uncial system. Oddly enough, the French Revolutionary Committee charged with setting up a new system of weights and measures gave, as one reason for rejecting base twelve proposals, their opinion that the common people would not comprehend it. They then proceeded to establish a new system of weights and measures which only further complicated an already confused set of systems, and prevented any real solution to the original problem.

Modern number problems have become so pressing that we *must* evolve a real coordinated system of numbers, weights, and measures. This can be done only by using 12 as a base. Ten has failed to fit into time, latitude, and board measure. But this base cannot be comprehended until the semantic blockage due to lack of proper words with which to convey the new ideas is removed. This can be done only by working out a nomenclature of terms founded on our existing words, so that association is always there to help identify the otherwise foreign language term.

This terminology for a number system based on 12 can be developed from our common word "dozen" and from the somewhat rare word "uncial," meaning twelfth part. If the first column to the left of the decimal point is called the *units* column, as now, then the second can be called the *dozens* column, placing the accent on *do* for second, and using *zens* as a general term signifying "by powers of twelve." The third column then becomes *tri-zens*, the fourth column *quadzens*, etc., to *none-zens*.

On the fractional side of the decimal point, we can take our cue from the Roman usage, in which each twelfth had a name, e.g., five twelfths was quincunx, seven twelfths septunx. Anglicizing the first syllable of these expressions, we get respectively *five-unx* and *seven-unx*. Any number in the first fractional column then can be expressed by simply adding *unx*. Again, using *unx* as a general term denoting fractions in powers of twelve, it follows that the second column numbers will merely take *dounx* as an ending, the third column will be *triunx*, and so on to *noneunx*. Grammatically speaking, the Latin ordinal numbers should be used, but *do-zen* sets the pattern for use of the shorter cardinal numbers.

After much study, the writer is of the opinion that a world which uses the Latin word "decimal" universally to express numbers in powers of 10, would be much more likely to adopt the Latin word *uncial* to express numbers in powers of 12, rather than the cumbersome *duodecimal*. Both ounce and inch derive from the Latin *uncial*, and other languages probably have similar word relationships. Since a number system must be a universal language, it follows that the terminology should be such as to lend itself to universal convenience and ease of adoption.

As we are expressing "ten" as a unit, it is necessary to have a single symbol for it, and a new name for the symbol. Again using association of terms, we

think new-ten, then ten-new, then ten-uncial, then contract to *ten-u* for our word. If we start our symbol as a lower case letter "t," we have only to backstroke along the serif to form a "t" resting in a "u."[1] For "eleven" we can simply say *elevenu*. If we start a lower case "e," we can turn the upper stroke into a "u."[1] Both flow rather naturally from the tongue, and the "new" sound at the end of each is easy to fix in the mind. The typewriter needs no change for the symbols, which can be touched up by hand later.

It is not unusual for genius to be ahead of its time, but Simon Stevinus seems to have outdistanced all the rest, for it is only recently that his opinions as regards base twelve have been verified and consideration given to its adoption. Such a change must be made very gradually and the honor of pioneering it can be had by the printers, the architects, the mechanical engineers, or the civil engineers.

The printer is in the best position, for his basic "line" measures 1/72 inch, 2 *dounx*. The Westcott typist's rule shows that "elite" type requires 12 spaces to the inch and it is so graduated. It shows that double-spaced lines are 3 to the inch and single-spaced lines 6 to the inch—all easily expressed as uncials. The type in common use all makes up at an even number of lines per inch. The system was based on the old Roman uncial system.

The architect uses the uncial division of the foot and needs only to adopt the same 3–6–9–12 pattern for the inch. Adoption of 1/3 foot as the base for modular design may set him thinking about the advantage of a system in which 1/3 inch is not an orphan.

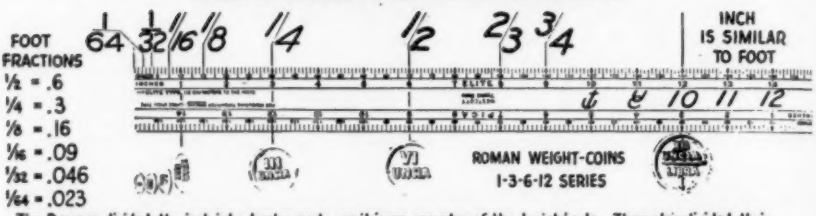
The mechanical engineer uses the 12-part foot and both the binary and decimal scale for the inch. He could make the switch to uncials pay an enormous dividend in savings on shop drawings, machining, and inspection. The cost of new micrometers and scales and the cost of education in new ideas stand in his path.

The civil engineer uses both the uncial and decimal foot. He uses the binary inch and for his office scales a strange mixture of decimal inches with miles or feet, which give such weird map ratios as 1/62,500 or 1/2,400. His mile is either 80 English chains or 52.8 stations. On land his contours are 5 feet but in water they are 1 fathom, which was 6 Grecian feet. He uses the pound as his unit of weight, divided into 16 ounces. The same ounce was once the 1/12 part of the Roman *libra*, and the 1/1000 part of the weight of their cubic foot of water, which was the basic unit of their system and from which ours is derived. He measures volumes in cubic yards, which as the cube of the old yard of 4 spans had a volume of 64 cubic spans, divisible in the octonary series, but as 27 cubic feet it divides only into thirds and ninths. The cubic foot is now almost exclusively used for dry measure, although for liquids both the cubic foot and the gallon are used. The gallon, once the measure of 1/8 cubic foot, was enlarged to the volume of a 7-inch cylinder 6 inches deep and no longer fits into the original system, being merely 231 cubic inches. He uses for his unit of circular measure a degree which is 1/60 of the original Sumerian unit; sometimes he uses the radian method, in which 57.3° is the unit; occasionally he uses the metric division, in which the unit is 1/400 part of the circle. He has no method of using a whole circle as unity, except on a revolution counter or meter.

From the foregoing it would seem that the printer might take the lead in adoption of base twelve numbers. But, human nature is such that he can drift along easily with the present system, as can the architect and the mechanical engineer. Man only changes his ways when he becomes uncomfortable, and the civil engineer is the only one who is in real distress, both from his own system and from the pressure for adoption of the metric units. Hence, it is the civil engi-

[1] See the accompanying tables for illustrations of this symbol.

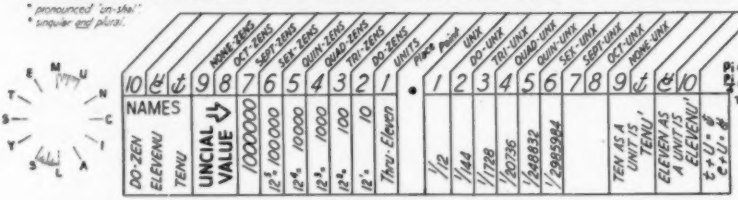
# EVOLUTION OF OUR MEASURES FROM ROMAN UNCIAL FRACTIONS




The Romans divided the inch into twelve parts, as it is on one edge of the typists' rule. They also divided their "uncia", our ounce, into twelve "little uncia", called "unx". Their coinage system also ran in the 1-3-6-12 series. All twelve parts had names and symbols and were known as UNCIAL FRACTIONS.

Had the Romans remained dominant until the advent of Arabic numerals, the zero concept and place value fractions, we would now be using twelve numbers instead of only ten. The ease with which the ½-¼....1/64 series can be expressed in only three uncial terms is a good sample of their universal superiority over the decimal numbers. The table below is an attempt to show what we might be using had they developed the UNCIAL NUMBERS.

* pronounced "on-shē"
* singular and plural


10 ↊ ↋ 9 8 7 6 5 4 3 2 1 • 1 2 3 4 5 6 7 8 9 ↋ ↊ 10
NONE-ZERS OCT-ZERS SEPT-ZERS SEX-ZERS QUIN-ZERS QUAD-ZERS TRI-ZERS DO-ZERS UNITS FIXED Point UNX DO-UNX TRI-UNX QUAD-UNX QUIN-UNX SEX-UNX SEPT-UNX OCT-UNX NONE-UNX
NAMES
DO-ZEN ELEVENU TENU
UNCIAL VALUE
10000000 12⁷=1000000 12⁶=100000 12⁵=10000 12⁴=1000 12³=100 12²=10 12¹=Thru-Eleven
1/12 1/144 1/1728 1/20736 1/248832 1/2985984
TEN AS A UNIT IS 'TENU'
ELEVEN AS A UNIT IS ELEVENU
↊+U=↋
↋+U=↊
Pi = 3.1848 084
Pi = .9512 024
√E = 1.4475
= 1.5 - .0043

Their system of weights and measures would also have developed along the lines dictated by the twelve number base, as the French decimal system was fitted to the ten number base. In the table below, present units are shown in capital letters, and seem to come from such an UNCIAL SYSTEM.

| Relative Sizes | 1/1728 | 1/144 | 1/12 | 1 | 3 | 6 | 9 | 12 | 27 | 36 | 72 | 144 | 1728 | 20736 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LINEAR | | Dinch | INCH | FOOT | YARD | FATHOM | | Dothom | | | | | | |
| WEIGHT | | Dounce | OUNCE | Libra | | | | | | | | | | |
| AREA | | SQ. INCH | | SQ. FT. | | | SQ.YD. | | | | | | | Uland |
| VOLUME CU.IN. | | | | CU. FT. | | | | | CU.YD. | | | | | ½ ACRE = 21780' |
| BOARD MEASURE | | | | BD. FT. | | | | CU.FT. | | | | | | |
| PRINTERS MEASURE | | | | POINT | | 6 POINT | 9 POINT | PICA | | | INCH=.9963 | | U.S.STANDARD INCH | |
| TIME 2⅔" | | 25 SEC. | 5 MIN. | HOUR | | | | ½ DAY | | | | | | |
| CIRCLE 5 5/24" | | 1°2½" | 12°30" | 2°30' | | | | 30° | | | | CIRCLE | | |
| UNCIAL TERM SIZES | | .01 | .1 | 1 | 3 | 6 | 9 | 10 | 23 | 30 | 60 | 100 | 1000 | 10000 |

The recently civilized Britons preferred the more primitive 2-4-8-16 series and altered the Roman system to suit their own ideas. They divided the inch on that scale and created a 16 ounce pound. The cubic foot was first divided by 8 to get a convenient unit of liquid measure. This unit was enlarged to almost equal in volume the popular French wine jug, the "jalon". Not until Queen Anne's reign did it become fixed at 231 cu. in., the present U.S. Standard. This size was adopted because it can be checked readily, being a 7 inch cylinder 6 inches deep. This "cylindrical" measure for fluids is used in the modern canning industry, for standardization reasons, and should supplant the gallon series. The "cylindrical" foot of 1728 cyl. inches is a concept that could simplify metal rod and pipe calculations. The table below shows these fluid sizes. The uncially divided dollar is shown merely to bring out the superiority of twelve as a base. Many trade items cannot be economically packed in groups of ten, but all pack by twelves.

| RELATIVE SIZE | 1/144 | 1/12 | 1 | 3 | 6 | 9 | 12 | 36 | 72 | 144 | 288 | 1728 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLUID MEASURE | | | | | | GILL | | PT. | QT. | 2 QTS. | GAL.=294 FL.IN. | |
| CYLINDRICAL | | | FLUID IN. | | | Discard | New | USE | USE | USE | Jalon | Fluid Ft |
| ERROR | | | | | | 3/16 FL.IN. | | 3/16 FL.IN. | 1½ FL.IN. | 3 FL.IN. | 6 FL.IN. = 3/144 | |
| DOLLAR | | Do-unx = 1/144 $ | | 3/144 $ | 6/144 $ | Unx = 1/12 $ | | ¼ $ | ½ $ | DOLLAR | | 12 $ |
| CENTS | | | .694+¢ | 2½¢ | 4⅙ ¢ | | 8⅓¢ | 25¢ | 50¢ | DOLLAR | | |

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# TABLE OF DECIMAL EQUIVALENTS

| | | | |
|---|---|---|---|
| 1/64 | .015625 | .023 | |
| 1/32 | .03125 | .046 | |
| 3/64 | .046875 | .069 | |
| 1/16 | .09 | .0625 | |
| 5/64 | .078125 | .08ℇ3 | |
| 3/32 | .09375 | .116 | |
| 7/64 | .109375 | .139 | |
| 1/8 | .16 | .125 | |
| 9/64 | .140625 | .183 | |
| 5/32 | .15625 | .1ℐ6 | |
| 11/64 | .171875 | .209 | |
| 3/16 | .23 | .1875 | |
| 13/64 | .203125 | .253 | |
| 7/32 | .21875 | .276 | |
| 15/64 | .234375 | .299 | |
| 1/4 | .3 | .25 | |
| 17/64 | .265625 | .323 | |
| 9/32 | .28125 | .346 | |
| 19/64 | .296875 | .369 | |
| 5/16 | .39 | .3125 | |
| 21/64 | .328125 | .3ℇ3 | |
| 11/32 | .34375 | .416 | |
| 23/64 | .359375 | .439 | |
| 3/8 | .46 | .375 | |
| 25/64 | .390625 | .483 | |
| 13/32 | .40625 | .4ℐ6 | |
| 27/64 | .421875 | .509 | |
| 7/16 | .53 | .4375 | |
| 29/64 | .453125 | .553 | |
| 15/32 | .46875 | .576 | |
| 31/64 | .484375 | .599 | |
| 1/2 | .6 | .5 | |
| 33/64 | .515625 | .623 | |
| 17/32 | .53125 | .646 | |
| 35/64 | .546875 | .669 | |
| 9/16 | .69 | .5625 | |
| 37/64 | .578125 | .6ℇ3 | |
| 19/32 | .59375 | .716 | |
| 39/64 | .609375 | .739 | |
| 5/8 | .76 | .625 | |
| 41/64 | .640625 | .783 | |
| 21/32 | .65625 | .7ℐ6 | |
| 43/64 | .671875 | .809 | |
| 11/16 | .83 | .6875 | |
| 45/64 | .703125 | .853 | |
| 23/32 | .71875 | .876 | |
| 47/64 | .734375 | .899 | |
| 3/4 | .9 | .75 | |
| 49/64 | .765625 | .923 | |
| 25/32 | .78125 | .946 | |
| 51/64 | .796875 | .969 | |
| 13/16 | .99 | .8125 | |
| 53/64 | .828125 | .9ℇ3 | |
| 27/32 | .84375 | .ℐ16 | |
| 55/64 | .859375 | .ℐ39 | |
| 7/8 | .ℐ6 | .875 | |
| 57/64 | .890625 | .ℐ83 | |
| 29/32 | .90625 | .ℐℐ6 | |
| 59/64 | .921875 | .ℇ09 | |
| 15/16 | .ℇ3 | .9375 | |
| 61/64 | .953125 | .ℇ53 | |
| 31/32 | .96875 | .ℇ76 | |
| 63/64 | .984375 | .ℇ99 | |
| 1 | 1. | 1. | |

neer who is most likely to accept the role of pioneer. The forthcoming celebration of the centennial of the American Society of Civil Engineers offers an opportunity to pay tribute to the pioneering spirit of our founder engineers, by launching an intensive program for the adoption of this radical change.

## Florida Highway and Surveying Conference

A COMBINED Highway and Surveying Conference will be held at Gainesville, Fla., on October 23 and 24, 1952. This will be the Sixth Annual Highway Conference and the Fifth Annual Surveying and Mapping Conference. The Civil Engineering Department of the University of Florida will sponsor this conference.

There will be general sessions of interest to both highway engineers and surveyors and sessions covering the application of photogrammetry to highway location; specialized sessions will also be held. The specialized sessions for the surveying group will be devoted to Land Surveying, with speakers from the Title Companies and the Bar Association, in addition to the Land Surveyors.

The objective of this conference is a dual one. First, it is to bring together those persons interested in Highway Engineering and those interested in Surveying and Mapping for a discussion of procedures and means of working together for the cooperative benefit of both of these fields of Civil Engineering. Second, these two groups in their own individual sessions will have an opportunity to exchange ideas on problems restricted to their particular fields.

## Third Surveying Teachers' Conference

THE Third National Surveying Teachers' Conference, in which 80 educators from 42 colleges and universities participated, was held August 3–8, 1952, at the Summer Survey Camp of the University of Illinois in the Chippewa National Forest, Minn. The conference was under the sponsorship of Committee VIII on Surveying and Mapping, Civil Engineering Division of the American Society for Engineering Education, and resulted in the adoption of a series of resolutions stressing the need for improvements in the present facilities and courses offered in surveying and mapping.

Prof. Paul P. Rice of Rutgers University, one of the leaders of the First National Surveying Teachers' Conference at Rainy Lake, Minn., in 1937, presented the keynote address in which he emphasized the importance of the educator's leadership in meeting the demands of the atomic age upon "the representatives of the oldest science which began when nomadic men became gregarious enough to settle the first primitive community."

Papers were presented by educators from 26 States and 3 provinces of Canada, and by representatives from 4 Government agencies and 5 private organizations. In general, the papers brought out the fact that the teaching profession has not kept pace with many advancements made during the past 10 years in the practice of surveying and mapping; that there is urgent need for extended research in these fields; and that industry and science demand better methods of measurement, greater accuracy, and the adaptation of surveys to new problems.

The topics covered in the sessions were: operation of summer camps and schools; presentation and discussion of teaching aids and techniques, including the use of audio-visual materials and published maps; discussion of instruments, current literature, and text books available to the surveying teacher. One day was devoted to a discussion of the evaluation of curricula for instruction in surveying and mapping and their relation to the profession of engineering. This led to the formulation of resolutions containing recommendations for strengthening the courses and training in our colleges and universities.

Proceedings of the conference will be published and available from the ASEE.

MILTON O. SCHMIDT

# Third-Order Surveys at Reasonable Cost[1]

*By* H. D. WALKER
U. S. GEOLOGICAL SURVEY

THROUGH the 3-year period in which the standards for highway surveys have been worked out, they have been carefully considered and revised by the members of the Highway Committee of the Control Surveys Division of the Congress. They have also been submitted to the American Association of State Highway Officials and to the Bureau of Public Roads for evaluation and recommendations. With due regard to suggestions received from many sources, these standards have been finally tailored into the present form.[2]

Although the majority of the representatives of the Committee on Design of the AASHO who reviewed the proposed standards considered them satisfactory, there was opposition to the adoption of the standards from a minority. This opposition seemed to be based on the belief that, although the adherence to a set of standards might be a desirable aim, it would cost too much. There is considerable evidence leading to the belief that costs need not be greatly increased; it is even possible that over-all costs can be reduced by better surveys.

First-order surveys for tunnels and major bridges or second-order surveys for expressways require highly refined methods and special equipment. The large bulk of the highway surveys that will be performed under the proposed standards will, however, be third-order surveys. This paper will briefly discuss methods that have been developed and used by the U. S. Geological Survey to run third-order surveys at reasonable cost for the control of mapping.

## TRANSIT TRAVERSE

The Geological Survey has used transit traverse for map control since 1891. The quantity of traverse run in recent years has averaged from 6,000 to 8,000 miles per year. The traverse must be accurate enough so that errors are within the limits of the plotting accuracy. For standard mapping scales, this requirement is met by third-order work. Methods had to be developed that would attain this accuracy but would not be unduly expensive. Traverse as run by the Geological Survey is essentially the same kind of a survey as the centerline survey of a highway. Numbered stations are not a uniform distance apart but correspond to the angle points or *PI*'s of a centerline.

*Instrumental work.*—The procedures used in measuring the angles and in keeping the notes are designed to be self-checking. Angles are measured by the deflection method. They are measured twice by repetition with a 30-second transit or a 1-minute optical-reading theodolite. When the transit is used, both verniers are read and the readings averaged for each pointing. The micrometer of the theodolite reads on only one side of the circle but readings are estimated to the nearest tenth of a minute. Angle measurements seem to be of about the same accuracy with either type of instrument.

Mean deflection angles are determined at each station and are added to or subtracted from the azimuth of the preceding course to obtain the azimuth of the course ahead. To facilitate checking, the plate reading remaining on the instrument after observations are completed at a station is retained and used as the starting plate reading at the next station. If the plates

[1] This paper was prepared for the panel discussion on "Technical Standards for Highway Surveys" conducted by the Control Surveys Division at the 1951 Annual Meeting. Time did not permit a presentation in full. —Ed.

[2] *See* "A Policy on Highway Surveys," page 325, Oct.–Dec. 1951 issue of SURVEYING AND MAPPING.

slip while the instrument is being moved, the correct reading is reset before angle measurements are begun at a new station. In this way the instrument accumulates twice the net deflection angle and an overall check can be made at any point in the line. Such a check reveals errors in arithmetic or mistakes in carrying over figures from one page to the next.

Efficient operation requires a recorder where there are many short courses. Where the courses are uniformly long, a good instrumentman can do his own recording without delaying the progress of the party.

Azimuths are checked against fixed controlling azimuths at intervals not greater than 5 miles or 50 courses. The controlling azimuths may be geodetic azimuths, which are available at nearly all triangulation stations, or they may be obtained by astronomic observations on the sun or the North Star. For purposes of third-order traverse, astronomic azimuths and geodetic azimuths may be used identically. Azimuths obtained from observations on Polaris are preferred to azimuths obtained from the sun because they are more accurate. Most of the observations are made in the daytime except when the work is near the coast where haze often makes it difficult to see the star.

The closure difference between a forwarded azimuth and a new controlling azimuth is made up of two elements; the accumulated instrumental error and, if the line has run east or west, the amount of the convergence of the meridians. The amount of this convergence is easily obtained by computation or from a nomograph (fig. 1). It is only necessary to know the approximate latitude and longitude of the ends of the section and these figures may be obtained by scaling from a good map. After the convergence has been removed the remainder of the closure is the accumulated instrumental error. The criterion for acceptable work is that it shall not exceed $40'' \sqrt{\text{number of angles}}$.

The procedures just outlined provide adequate checks on the accuracy of the angle measurements. Experience has shown that, when these safeguards are observed, errors in the instrumental work are seldom the cause of poor line closure.

*Taping.*—Measurement of distance has always been the source of most of the errors responsible for poor closures of transit-traverse lines. The importance of work requiring first- or second-order traverse has justified the use of refined methods involving special equipment and large taping parties. Third-order traverse, however, would be economically impractical if all these refinements were demanded. Experience of the Geological Survey has demonstrated that line closures of third-order accuracy can be consistently attained with only minor refinements in the methods of taping used for ordinary surveys.

The standard taping method is to maintain the tape horizontal during measurement, to project the measured lengths to the ground with plumb bobs, to exert the proper tension with the help of a spring balance and to line in the breaks by eye. 300-foot tapes are used in comparatively flat country but no measurement is made with more than 100 feet of tape suspended between supports. 100-foot tapes are more convenient in mountainous country or on roads where traffic is heavy. With the advent of the electric calculating machine, refinements in the computing processes became practical with little or no increase in computing costs and full advantage could be taken of all the accuracy inherent in the field work. Thus, with the aid of a rather ingenious chart devised by R. M. Wilson of the U. S. Geological Survey, corrections for temperature and reductions to sea level can be applied simultaneously and with little extra effort.[3]

The tapes used are of the standard highway drag type graduated in foot units. Each tape has an extra foot, graduated in tenths and hundredths, preceding the

[3] The size of this chart does not permit its reproduction in this Journal. A copy will be provided free upon application to the Map Distribution Office, U. S. Geological Survey, Washington 25, D. C.

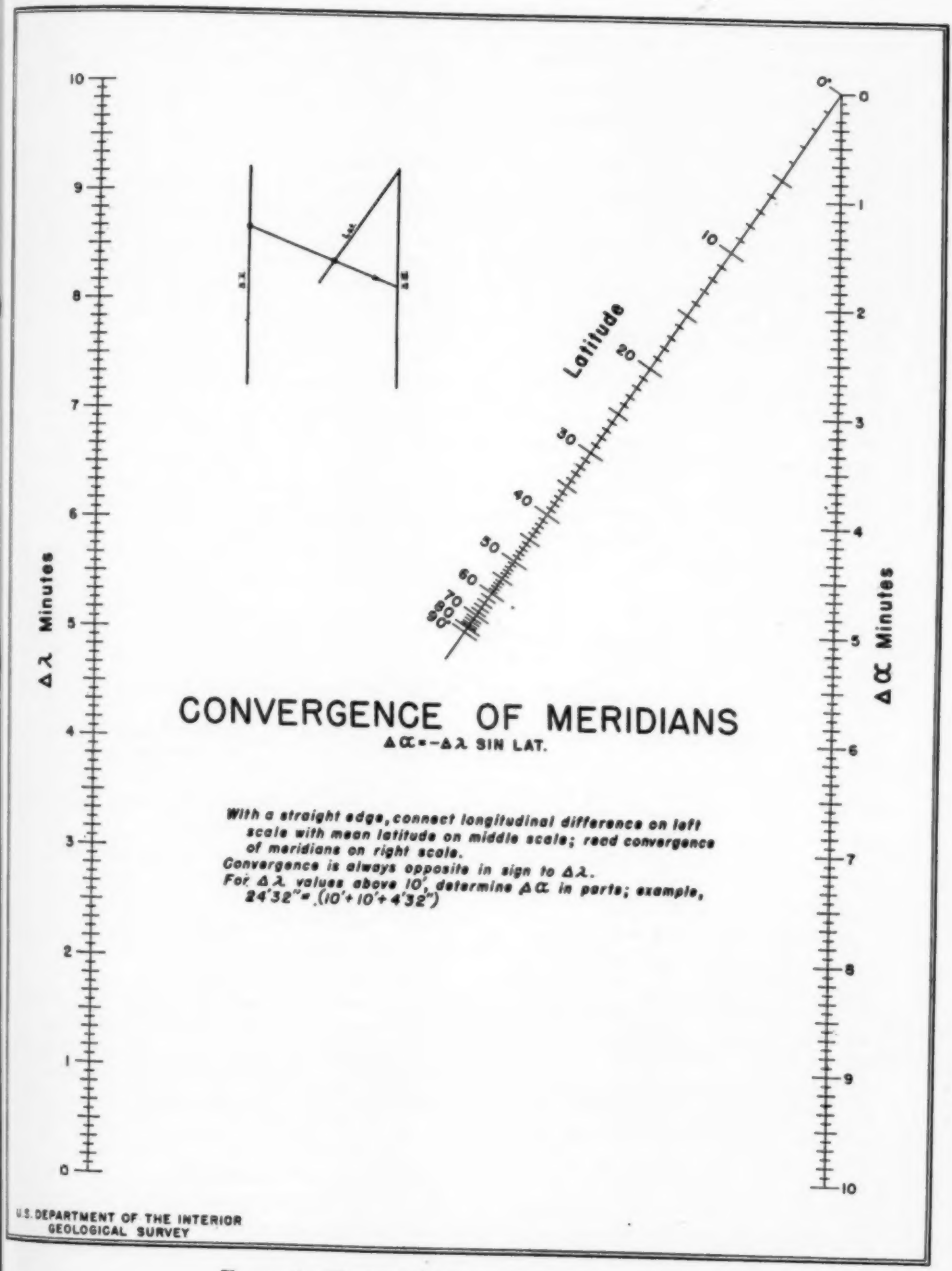
Δλ Minutes
Latitude
ΔC Minutes
CONVERGENCE OF MERIDIANS
ΔC = −Δλ SIN LAT.
With a straight edge, connect longitudinal difference on left scale with mean latitude on middle scale; read convergence of meridians on right scale.
Convergence is always opposite in sign to Δλ.
For Δλ values above 10', determine ΔC in parts; example, 24'32" = (10'+10'+4'32")
U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FIGURE 1.—Nomograph for convergence corrections.

zero mark and having the tenths numbered in the direction opposite the numbering of the feet on the body of the tape. Thus for any measurement involving a fractional foot, the fraction is measured at the front and is simply added to the number of whole feet measured. The number of the tape in use is always recorded. Each operating Region of the Geological Survey has been supplied with a master tape of the same make, weight, and dimensions as the tapes used in the field work. These master tapes have been standardized at the National Bureau of Standards. Before working tapes are issued to a field party and at intervals thereafter when the party is passing through Regional Headquarters, these working tapes are compared with the master tape.

Records of temperature are kept during the field work. When most of the measurements are being made with the tape suspended, the thermometer is suspended in the air. If most of the measurements are being made with the tape supported throughout, the thermometer is laid face down on the ground or on the pavement. Temperature readings are usually made by the instrumentman unless he has permitted the tapemen to get considerably ahead of him. The question of obtaining the true temperature of a tape has always been a difficult one but the method described here has given satisfactory results for third-order traverse. It has been found that, except in the early morning or late afternoon when temperatures are rising or falling rapidly, one temperature reading will serve for several courses. Additional readings are needed if the line suddenly goes from sunlight to shade or from shade to sunlight.

The master tapes are tested at the Bureau of Standards under 20-pound tension. In the field, the working tapes are always used under a tension of 20 pounds and it is thus not necessary to correct for tension; but an exception is made for suspended spans of between 75 and 100 feet. With 20 pounds tension and a suspended span of this length, the shortening due to sag is in excess of the allowable error for third-order work. It would be possible to stretch the tape by increasing the tension to compensate exactly for the shortening due to sag. Such a solution is complex because it requires a different tension for each different length of suspended span. As a workable, practical solution an arbitrary rule has been adopted to increase the tension to 25 pounds for any span between 75 and 100 feet in length. Although this does not exactly compensate the error it reduces it within acceptable limits.

New tapemen quickly grasp the idea that poor alignment introduces errors into measured lengths but it is more difficult to convince them that errors equally as great are introduced by failure to maintain the tape level during measurements. Both tapemen carry hand levels and the man at the lower elevation is required to use his to determine the correct height to plumb for each break of the tape. In training new tapemen, a quick way of impressing them with the need for careful work has been found. They are assigned several courses to tape on a medium slope. After completing them, they are recalled and required to remeasure the same courses under the close supervision of the party chief. After a second or third measurement of the same courses, the idea has usually taken firm root.

Two other methods of taping have been introduced in recent years and have proved capable of giving third-order results. Both are methods of slope taping in which corrections for slope are applied on the ground. They are fast and have the advantage that only the front tapeman needs to have special ability or training. Both methods involve measurements along the surface of the ground, between breaks in ground slope, with the application in the field of slope corrections based on the length of the slope measurement and the difference in elevation between its ends. The front tapeman refers to a table to obtain the correction (fig. 2). He applies it by advancing the pin ahead of the zero mark an amount sufficient to make

| Diff. Elev. (ft.) | Slope Measurement (Feet) | | | | | | | | | | | | | | | | | | | | | | | | | | Diff. Elev. (ft.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 300 | 290 | 280 | 270 | 260 | 250 | 240 | 230 | 220 | 210 | 200 | 190 | 180 | 170 | 160 | 150 | 140 | 130 | 120 | 110 | 100 | 90 | 80 | 70 | 60 | 50 | |
| 2 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 02 | 02 | 02 | 02 | 02 | 02 | 03 | 03 | 04 | 2 |
| 3 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 03 | 03 | 03 | 03 | 03 | 04 | 04 | 04 | 05 | 06 | 07 | 08 | 09 | 3 |
| 4 | 03 | 03 | 03 | 03 | 03 | 03 | 03 | 03 | 04 | 04 | 04 | 04 | 04 | 05 | 05 | 05 | 06 | 06 | 07 | 07 | 08 | 09 | 10 | 11 | 13 | 16 | 4 |
| 5 | 04 | 04 | 04 | 04 | 05 | 05 | 05 | 05 | 06 | 06 | 06 | 07 | 07 | 07 | 08 | 08 | 09 | 10 | 10 | 11 | 12 | 14 | 16 | 18 | 21 | 25 | 5 |
| 6 | 06 | 06 | 06 | 06 | 07 | 07 | 07 | 08 | 08 | 08 | 09 | 10 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 | 18 | 20 | 23 | 26 | 30 | | 6 |
| 7 | 08 | 08 | 09 | 09 | 09 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 16 | 18 | 19 | 20 | 22 | 24 | 27 | 31 | 35 | | | 7 |
| 8 | 11 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 23 | 24 | 27 | 29 | 32 | 36 | 40 | | | | 8 |
| 9 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 24 | 25 | 27 | 29 | 31 | 34 | 37 | 41 | | | | | | 9 |
| 10 | 17 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 28 | 29 | 31 | 33 | 36 | 38 | 42 | | | | | | | | 10 |
| 11 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 28 | 29 | 30 | 32 | 34 | 36 | 38 | 40 | 43 | | | | | | | | | | 11 |
| 12 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 34 | 36 | 38 | 40 | 42 | 45 | 48 | | | | | | | | | | | 12 |
| 13 | 28 | 29 | 30 | 31 | 32 | 34 | 35 | 37 | 38 | 40 | 42 | 45 | 47 | 50 | | SLOPE ALLOWANCE CORRECTIONS | | | | | | | | | | | 13 |
| 14 | 33 | 34 | 35 | 36 | 38 | 39 | 41 | 43 | 45 | 47 | 49 | 52 | 55 | | | (Hundredths of Feet) | | | | | | | | | | | 14 |
| 15 | 38 | 39 | 40 | 42 | 43 | 45 | 47 | 49 | 51 | 54 | 56 | | | | | | | | | | | | | | | | 15 |
| 16 | 43 | 44 | 46 | 48 | 49 | 51 | 53 | 56 | 58 | | (Corr. = Dist. x exsec V. A.) | | | | | | | | | | | | | | | | 16 |
| 17 | 48 | 50 | 52 | 54 | 56 | 58 | 60 | | | | | | | | | | | | | | | | | | | | 17 |
| 18 | 54 | 56 | 58 | 60 | 63 | 65 | | | | | Advance pin on the ground the amount of correction to | | | | | | | | | | | | | | | | 18 |
| 19 | 60 | 62 | 65 | 67 | | | | | | | obtain horizontal component equal the original slope | | | | | | | | | | | | | | | | 19 |
| 20 | 67 | 69 | | | | | | | | | measurement. | | | | | | | | | | | | | | | | 20 |

Form 313-14a

FIGURE 2.—Corrections for step method of slope taping.

| V. A. (Degrees) | SLOPE MEASUREMENT (Feet) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 |
| ½ | | | | | | | | 01 | 01 | 01 | 01 | 01 | 01 |
| 1 | 01 | 01 | 01 | 01 | 01 | 02 | 02 | 02 | 02 | 02 | 02 | 02 | 03 |
| 1½ | 02 | 02 | 02 | 03 | 03 | 03 | 04 | 04 | 05 | 05 | 05 | 05 | 06 |
| 2 | 03 | 04 | 04 | 05 | 06 | 06 | 07 | 07 | 08 | 09 | 09 | 10 | 10 |
| 2½ | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 |
| 3 | 07 | 08 | 10 | 11 | 12 | 14 | 15 | 17 | 18 | 19 | 21 | 22 | 23 |
| 3½ | 09 | 11 | 13 | 15 | 17 | 19 | 21 | 22 | 24 | 26 | 28 | 30 | 32 |
| 4 | 12 | 15 | 17 | 20 | 22 | 24 | 27 | 29 | 32 | 34 | 37 | 39 | 42 |

| V. A. | SLOPE MEASUREMENT | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 |
| ½ | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 | 01 |
| 1 | 03 | 03 | 03 | 03 | 03 | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 05 |
| 1½ | 06 | 07 | 07 | 07 | 08 | 08 | 08 | 09 | 09 | 09 | 10 | 10 | 10 |
| 2 | 11 | 12 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 18 |
| 2½ | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 3 | 25 | 26 | 27 | 29 | 30 | 32 | 33 | 34 | 36 | 37 | 38 | 40 | 41 |
| 3½ | 34 | 36 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 52 | 54 | 56 |
| 4 | 44 | 46 | 49 | 51 | 54 | 56 | 59 | 61 | 64 | 66 | 68 | 71 | 73 |

Form 313-14
4-8-47

SLOPE ALLOWANCE CORRECTIONS

(Hundredths of Feet)

(Corr. = Dist. x exsec V. A.)

Advance pin on the ground the amount of correction to obtain horizontal component equal the original slope measurement

FIGURE 3.—Corrections for clinometer method of slope taping.

the horizontal component of the slope measurement, plus the correction, equal to the original slope measurement without the correction. In the first method, the difference in elevation between ends of a measurement is obtained by measuring eye-height steps with a hand level. Parties using this method average about 6 miles a day and with well-trained tapemen the closures are uniformly good. The second method is much the same except that the corrections are based on measurements of the slope angles made with clinometers (fig. 3). It is faster on long uniform slopes such as are encountered on the grades of a modern highway but is not as fast as the other method where slope changes are very frequent. Neither method is used where slopes are steeper than 20 feet in 300 feet; when steeper slopes are encountered, measurements must be made by the standard plumbing method.

The taping methods just outlined are designed to remove systematic errors. Successful traverse, closing within speci-

fied limits, is dependent upon careful and conscientious work by the tapemen. This need not be slow work. One or two days of training under the close supervision and instruction of an experienced man before starting new tapemen on production has been found to pay. Emphasis in this training should be on the need for careful work and the proper use of the taping equipment. Handling the spring balance, hand level, and plumb bob is awkward at first but this awkwardness will soon disappear as proper habits become ingrained. After a proper start, tapemen will rapidly pick up speed in their work.

Before leaving the discussion of traverse, some attention should be given to the subject of blunders. The methods used for the instrument work and recording are designed to provide checks and detect blunders in the angle work. When carefully followed, these methods work so successfully that undetected blunders in the angle work are seldom responsible for a failure to close. The most common causes of poor closures are undetected blunders by the tapemen. These blunders are usually mistakes in addition, the omission of a break, or, more rarely, the inclusion of an extra break or tape length. The best method that has been found for the detection of such blunders is to make stadia check readings ahead of the instrument. The front rodman carries a stadia rod, as well as a range pole. The strumentman makes a stadia reading to each located point and to the far end of each course before he knows the distances obtained by the tapemen.

## LEVELING

Most of the present-day leveling of the Geological Survey is done with prism levels and precise invar strip rods graduated in yards. Increased accuracy was not the chief aim when this kind of equipment was adopted. The main advantage for third-order leveling was to increase the speed of the work and thereby reduce costs. Many thousands of miles of satisfactory third-order, and some second-order, lines of leveling have been run with wye or dumpy levels and with wooden rods.

The principles involved in leveling are simple ones but certain refinements in field methods are necessary if elevations are to be determined to fixed standards of accuracy. The process of running lines of leveling consists of many repetitions of the same kind of operations and it is susceptible to the rapid accumulation of error. Small errors, which are altogether insignificant in determining elevations for a construction job where only a few setups are necessary between the reference bench mark and the desired points, tend to accumulate in long lines of leveling to the point where the resulting error exceeds the allowable limit.

Errors in elevation determined by leveling stem from a number of sources. The chief sources may be itemized in the following order:

1. Lack of parallelism between the line of sight and the axis of the bubble tube resulting from poor adjustment of the level.
2. The combined effect of curvature of the earth and refraction of the atmosphere.
3. Failure to have the bubble centered when readings are made.
4. Errors in the length of the rod.
5. Failure to hold the rod plumb.
6. Settling of turning points.

The errors resulting from the first two sources can be entirely eliminated by limiting the maximum depth of sight to 300 feet and by making each foresight equal in length to the preceding backsight. Where balanced sights are impractical because of a steep grade, enough unequal sights to balance should be taken as soon as the grade is passed. All levels used by the Geological Survey are equipped with stadia hairs and the length of each foresight and backsight is read and recorded. Total foresight and backsight distances are added and should never fail to balance by more than 1,000 feet when the elevation of a new bench mark is to be determined.

Levels should be kept in good adjustment. Peg tests should be made at the

beginning and end of lines and at bench marks where total foresights and backsights have not been brought to balance within 100 feet. From these tests, *C* corrections are determined. *C* corrections show the fraction of a foot per 100 feet by which the instrument fails to sight a truly horizontal line when the bubble is centered. They should be applied to the elevations of all bench marks where foresights and backsights do not balance within 100 feet.

The levelman should always be careful to see that the bubble is centered before making readings on the rod. The most outstanding advantage of the prism level over the ordinary wye or dumpy level is that it permits the levelman to view the bubble at the same time he makes his readings and provides a fine adjustment for centering the bubble when he is standing in the observing position. With the ordinary level the levelman must carefully center the bubble before making a backsight and check after making it, then recenter, if necessary, before making a foresight and check after it is completed.

The accuracy of a circuit of leveling depends as much on the rods as it does on the instrument. Wooden rods change length with changes in their moisture content. They should be protected from rain and should be kept in their cases when not in use. Before being accepted for use on third-order leveling, the spacing of the graduations should be checked with an invar or steel tape and similar checks should be made at intervals during the period the rod is in use. If graduation errors are small, rod corrections are usually ignored for third-order lines unless large differences in elevation are involved. Rods must be equipped with plumbing bubbles and these bubbles must be maintained in good adjustment.

Settling of turning points is avoided by the use of metal turning pins in firm ground and metal turning plates in sand or soft ground. The shoe of the rod must be kept free of dirt.

For third-order leveling with dumpy or wye levels and target rods, separate sets of notes are kept by the levelman and the rodman. Each of them independently reads the target. After the rodman reads the target for a backsight, he carries the rod forward to the levelman without moving the target. On foresights, the levelman reads the target when he walks by the rodman. When the rod is lengthened beyond 7 feet, the rodman and the levelman must examine the target setting before reading the rod vernier. When the rod is closed they should see that the rod vernier indicates 7 feet, and not depend on the abutting ends to bring it back to place.

The subject of leveling should not be dismissed without some consideration of orthometric corrections. These are necessary because any two level surfaces at different altitudes are vertically nearer together at the poles than they are at the equator. Orthometric corrections are always applied to first- and second-order lines of leveling. The magnitude of the correction is dependent upon the latitude, the altitude, and the north-south difference between the ends of the line. They may, or may not, be large enough to be of significance in third-order leveling. Thus, in Florida, orthometric corrections could safely be ignored for third-order work unless very long, north-south lines were run. The same condition would apply to certain of the mid-western States which are at a low altitude. In Montana, a State of middle latitude and high elevations, a long north-south line could not be expected to close within limits if orthometric corrections were not applied.

Transit traverse and leveling are both continuous surveys run along the ground and are therefore susceptible to the accumulation of error. Conformity to a standard can best be achieved by the adoption of routine procedures designed to eliminate systematic errors and the use of checks to detect blunders. The experience of the Geological Survey has shown that third-order accuracy can be obtained without excessive cost when simple refinements are introduced into the use of ordinary equipment.

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# State Plane Coordinates in Route Surveying

*By* HUGH C. MITCHELL (Retired) and LANSING G. SIMMONS
U. S. COAST AND GEODETIC SURVEY

THE MATERIAL in this paper was prepared as an introduction to the subject of route surveying using the State Coordinate Systems. By using the State Plane Coordinates in this type of surveying, not only can advantage be taken of the horizontal control network of the country with its inherent stability, but the calculations can also be carried out by the formulas of plane trigonometry. The subject is discussed in a general way and several examples of typical problems are given.

Comparatively little use has been made of traverse in the solution of route survey problems, but with the increasing availability of coordinates on State-wide grids, and the advantages which the use of such coordinates bring to land and engineering surveys, it seems probable that such use will develop a future importance much greater than can now be predicted. The field is there and the opportunity also, as the tools —State coordinates—are becoming almost daily more generally available.

The use of plane-rectangular coordinates, be they on a local grid or on a State-wide system, is accomplished by traverse surveying, although there are situations where triangulation may be employed to considerable advantage. These are matters for the surveyor to determine. The present purpose of this study is to show how the coordinates of sought-for points on a route survey may be obtained from coordinate data which describe the fixed conditions controlling the problem.

This purpose will be served by presenting a series of problems, not necessarily typical of those the route survey may bring out, but basic thereto, whose solution will show the way to the solution of specific problems.

Route surveys include surveys for locating or relocating railroads, highways, pipe lines, transmission lines, etc. The employment of State coordinates in such surveys, gives them the qualities of *accuracy* and *permanency*, and by making considerable field work unnecessary may be productive of considerable *economy*. The substitution of office computations for some field surveys is also a great *convenience*. In route surveys, the use of the random line is largely eliminated by the use of coordinates, though there will be cases where the random line is used as a base line from which side shots determine desired locations on the route, and at the same time, obstacles along the route are avoided.

If a road is to be relocated in part, curves eliminated or reduced, the use of coordinates makes it easy to transfer plans made in the office to positions on the ground. If a new road is to be run directly between points on other roads, and the coordinates of those points are known, a direct line can be computed and if no obstacles intervene, run out on the ground without the use of a random line. If obstacles intervene, but a direct line is to be located, a traverse is run, coordinates of traverse stations determined, from which coordinates of points on the line can be established on the ground. This is a very flexible procedure.

In a road survey, where a curve is reached, the coordinates of the center of a circular curve can be computed from the coordinates of the point of curvature (*PC*), the radius of the curve, and the azimuth of the tangent. From the center, with the known radius and various azimuths, other points on the curve are determined. These are easily transferred to the ground.

If it is desired to establish 100-foot stations along a curve, the coordinates of the stations are computed from the center, with the given radius and the azimuths to the points obtained with central angles. The central angle will be built up from the

azimuth to the *PC*; account is taken of whether arc or chord is used.

A traverse along the route of the curve may provide the simplest method of locating the curve on the ground. With a traverse, obstacles may be dodged and points set between the obstacles. A clear line of sight along the curve will not be necessary. This is an advantage in a preliminary survey. If the total curve is to be composed of a series of simple curves of different radii, the procedure will be about as follows: When the *PC* is reached, the first curve is established by determining its center, and points along the curve as noted elsewhere. When the point of change of curvature (*PCC*) is reached, the center of the second curve is computed, using the coordinates of the *PCC*, the new radius, and the azimuth of the radius of the first curve to this *PCC*. Points on the second curve are then computed from its center, and so on, through a series of any number of curves, until the point of tangency (*PT*) is reached.

Some examples of specific procedure are described:

A straight line on a grid is defined by (*a*) the coordinates of its end points, or by (*b*) the coordinates of one end point and its length and azimuth.

(*a*) If the coordinates of its end points are known, its length and azimuth are obtained by computation. If the coordinates of the ends of the line *AB* are, for *A*, $x_1$, $y_1$, and for *B*, $x_2$, $y_2$, its length is

$$L = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

and its azimuth is obtained by the formula

$$\text{tangent of azimuth} = \frac{(x_1 - x_2)}{(y_1 - y_2)}.$$

Representing $(x_1 - x_2)$ by $\Delta x$ and $(y_1 - y_2)$ by $\Delta y$, these formulas become

$$\text{length} = \sqrt{(\Delta x)^2 + (\Delta y)^2}$$

$$\text{tangent of azimuth} = \frac{\Delta x}{\Delta y}.$$

As azimuths are reckoned from south clockwise through 360°, attention must be given the signs of $\Delta x$ and of $\Delta y$.

The following table is useful:

| Quadrant | Azimuth | sine | cosine | tangent | $\Delta x$ | $\Delta y$ |
|---|---|---|---|---|---|---|
| S.W. | 0°– 90° | + | + | + | + | + |
| N.W. | 90°–180° | + | − | − | + | − |
| N.E. | 180°–270° | − | − | + | − | − |
| S.E. | 270°–360° (or 0°) | − | + | − | − | + |

(*b*) If the coordinates of *A* ($x_1$, $y_1$) are known, and the length *L* of *AB* and its azimuth, *Az*, the coordinates of *B* are obtained by subtracting the values of $\Delta x$ ($= L \sin Az$) and $\Delta y$ ($= L \cos Az$) from $x_1$ and $y_1$. The subtraction is algebraic, due regard being had for signs.

Considering $\Delta x$ and $\Delta y$ as numerical quantities only, the following rules show their application to $x_1$, $y_1$ to obtain $x_2$, $y_2$:

In S.W. quadrant, subtract $\Delta x$ and $\Delta y$,
In N.W. quadrant, subtract $\Delta x$ and add $\Delta y$,
In N.E. quadrant, add $\Delta x$ and $\Delta$y,
In S.E. quadrant, add $\Delta x$ and subtract $\Delta y$.

Many problems in route surveying concern curves, and the positioning of curves with respect to tangents. In this work, it is often sufficient to know only a point on the tangent and the azimuth of the tangent. The problem most often starts with a tangent or tangents, and determines a curve to fit prescribed conditions. Various

problems will be considered. These are intended to show the method of computation, rather than to serve as examples of route layouts.

The circle is the simplest curve employed in route surveys. A circle may be defined by the coordinates of its center and the length of its radius. An arc of a circle may be defined by the coordinates of its center and the coordinates of its end points; also by the coordinates of its center, the length of its radius and the azimuths of its limiting radii. Given the coordinates of the center of the circle and the length of its radius, points on its circumference may be computed for each of a series of radial azimuths by applying the $\Delta x$ and $\Delta y$ for each of the azimuths to the coordinates of the center.

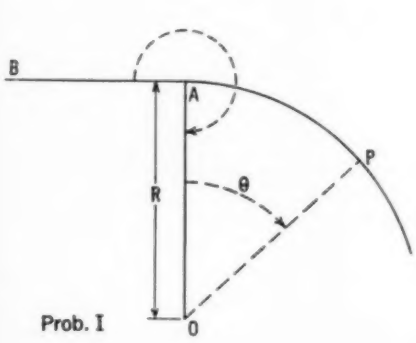
While each of the following examples is a complete problem, they are arranged in order of increasing complexity, and should be studied in that order. As a general rule, if the problem admits of graphical solution, the computation of coordinates may follow the plan of the graphical solution.

## PROBLEM I

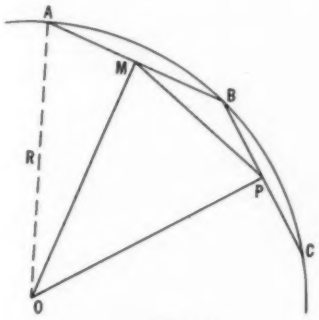
Given the coordinates of a point $A$, the azimuth of a tangent $AB$, and the radius $R$ of a circle tangent to $A$: To define the circle and determine points on it. Two such circles may be constructed, but only one will be illustrated.

*Construction.*—Draw $AO = R$, perpendicular to $AB$ at $A$. $O$ is the center of the required circle. With the radius $R$ and center $O$, the circle may be drawn. Any point, such as $P$, on the circle may be defined by the angle $\theta$ which the radius to the point makes with the radius $AO$.

*Computation.*—Compute the azimuth of $A$-$O$ by adding the angle at $A$, 270° reckoned in a clockwise direction, between $B$ and $O$, to the azimuth of $A$-$B$. With this azimuth and the length $R$, compute the $\Delta x$ and $\Delta y$ of $O$ relative to $A$, and apply these to the coordinates of $A$. This gives the coordinates of $O$. For any point on the circle, such as $P$, defined by the angle $\theta$, first compute the azimuth of $O$-$A$ by adding or subtracting 180° to the azimuth $A$-$O$. To this azimuth add the angle $\theta$. This gives the azimuth of $O$-$P$; coordinates of $P$ are then computed from the coordinates of $O$.



Prob. I



Prob. II

## PROBLEM II

Given the coordinates of the points $A$, $B$, and $C$: To determine and define a circle passing through these three points.

*Construction.*—Draw $MO$ perpendicular to $AB$ at its center point $M$, and $PO$ perpendicular to $BC$ at its center point $P$. The point of intersection $O$ is the center of the required circle. Lines to $A$, $B$, and $C$ are equal and are radii of the circle.

*Computation.*—Using coordinates, compute the azimuths of $A$-$B$ and $B$-$C$, and the coordinates of the center points, $M$ and $P$. Compute the azimuths of $M$-$O$ and $P$-$O$, which are perpendicular to $AB$ and $BC$. Using coordinates, compute the length and azimuth of $MP$. In the triangle $OMP$, the side $MP$ is known, and also the azimuths of the three sides, and therefore the three angles of the triangle.

Solve the triangle for the other sides, $OM$and $OP$. With these sides and their azimuths, compute the coordinates of $O$ from $M$ and $P$, obtaining two sets of values which must check. Using the coordinates of $O$ and of $A$, compute the length of the radius $OA$. Identical values should be obtained for $OB$ and $OC$.

The circle can be defined by the coordinates of $O$ and of a point on the circle; by coordinates of $O$ and radius $R$; and by the coordinates of $A$, $B$, and $C$.

## PROBLEM III

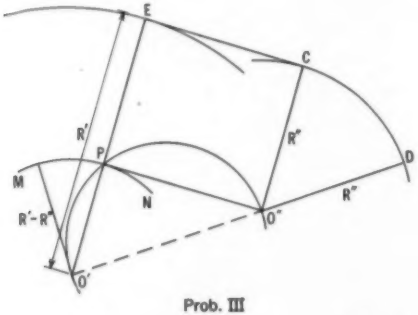
Given the coordinates of the centers and the lengths of radii of two circles: To determine a tangent common to the circles.

*Construction.*—$O'$ and $R'$ define one circle, $O''$ and $R''$ the other. Draw $O'D$ through $O''$ to $D$ on second circle. With $O'$ as center and radius equal to $R' - R''$ draw arc $MN$, cutting circle constructed on $O'O''$ as a diameter, at point $P$. Draw $PO''$. The required tangent will be equal to $PO''$ and parallel to it. The point $E$ will be on the radius through $P$, and $C$ will be on the radius parallel to $O'E$.

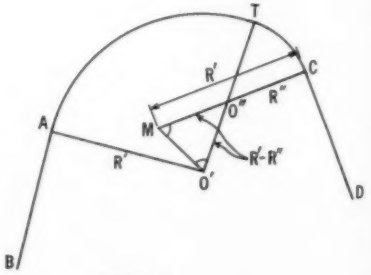
The figure $ECO''P$ is a rectangle. The angles at $O''$ and $P$ are right angles by construction, and the sides $EP$ and $CO''$ are equal to the radius $R''$. The line $EC$ is tangent to the first circle at point $E$, and to the second circle at point $C$.

*Computation.*—In the triangle $PO''O'$, the angle at $P$ is a right angle, the side $O'P$ is equal to $R' - R''$, and the length and azimuth of the side $O'O''$ are computed from the coordinates of $O'$ and $O''$. The triangle is solved for the remaining angles and the side $PO''$.

The azimuth of $O'$-$E$ is obtained with the azimuth of $O'$-$O''$ and the angle $O''O'E$. With these data, the coordinates of $E$ are computed from the coordinates of $O'$. The azimuth of $O''$-$C$ is the same as for $O'$-$E$, and $O''C$ equals $R''$. With these data, the coordinates of $C$ are obtained from the coordinates of $O''$. The coordinates of $C$ can also be obtained from $E$ with the length of $EC = PO''$, and the azimuth of $E$-$C$, which is the same as the azimuth of $P$-$O''$, at right angles to $O'E$.




Prob. III




Prob. IV

## PROBLEM IV

Given the coordinates of points $A$ and $C$ and azimuths of tangents $AB$ and $CD$: To determine and define two circular arcs tangent at $A$ and $C$ to the lines $AB$ and $CD$ and tangent to each other.

To obtain a specific solution, the radius of one circle must be known. The value $R'$ for a circle tangent to $AB$ at $A$ is assumed.

*Construction.*—Plot $O'$, the center of known circle, by laying off $AO'$ equal to $R'$ and at right angles to $AB$ at $A$. Plot $M$, by laying off $CM$ equal to $R'$ and perpendicular to $CD$ at $C$. Connect $M$ and $O'$. Construct angle $MO'T$ equal to angle $CMO'$ and lay off $O'T$ equal to $R'$. Then $O''M = O''O'$ and $O''T$ will equal $R''$, the radius of the required circle, $O''C$.

With $R'$ as radius and center at $O'$ construct arc $AT$; with $O''$ as center and radius $O''C = O''T$, construct arc $TC$. $ATC$ is the required curve.

*Computation.*—From coordinates of A, with radius $R'$ and azimuth 90° from azimuth of $A$-$B$, compute coordinates of $O'$.

From coordinates of $C$, with $R'$ and azimuth 90° from azimuth of $C$-$D$, compute coordinates of $M$.

From coordinates of $O'$ and of $M$, compute length and azimuth of $O'M$.

Obtain angle $CMO'$ from azimuths. Make angle $MO'T$ equal to angle $CMO'$.

Solve triangle $O''O'M$ for side $O''M = O''O'$.

Compute coordinates of $O''$ from $O'$ and, for check, from $M$.

Compute coordinates of $T$ from $O'$ with radius $R'$ and azimuth of $O'O''$. Check coordinates of $T$ by computation from $O''$ with $R''$ and azimuth $O'O''$.

$O'$ is center of arc $AT$.

$O''$ is center of arc $TC$.

Coordinates of points on these arcs can be computed from their centers with appropriate radii ($R'$ or $R''$) and selected azimuths.

There are many variations of problem IV, depending upon the relative positions of the points $A$ and $C$, the azimuths of the tangents, and the value adopted for $R'$. A few examples are shown in the following figures. These are lettered to conform to the one demonstrated.

Given the coordinates of $A$ and $C$, and azimuths of $AB$ and $CD$: To determine two circles connecting these tangents.

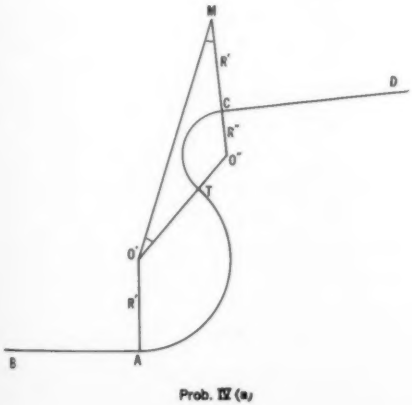
To obtain a specific solution, one radius must be known. Assume $R'$ as known. This fixes the solution, as follows: In the triangle $CO''O'$, we have the side $O'C$, whose length and azimuth are computed from coordinates of $O'$ and $C$. We also have the $\angle O'CO''$, the difference of the azimuths of $CO'$ and $CO''$ (perpendicular to $CD$). The side $O''O'$ is the sum $(R'' + R')$, $R'$ known, $R''$ sought.

$$(R'' + R')^2 = R''^2 + (CO')^2 - 2R''(CO') \cos \angle O'CO''$$

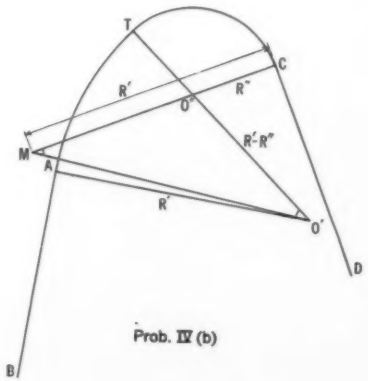
$$R''^2 + 2R''R' + R'^2 = R''^2 + (CO')^2 - 2R''(CO') \cos \angle O'CO''$$

$$R''[2R' + 2(CO') \cos \angle O'CO''] = (CO')^2 - R'^2$$

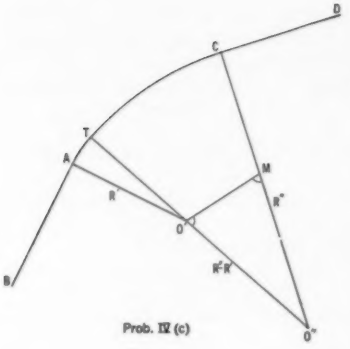
$$R'' = \frac{(CO')^2 - R'^2}{2R' + 2(CO') \cos \angle O'CO''}$$



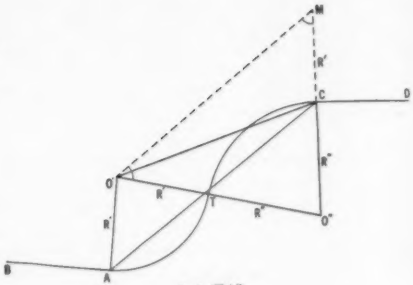

Prob. IV (a)




Prob. IV (b)




Prob. IV (c)




Prob. IV (d)

## PROBLEM V

The following problem illustrates a numerical example of the American Railway Engineering Association ten-chord spiral curve computed on a State Coordinate System.

Given: Two tangents intersecting at *P.I.* (station 48 + 46.82). The State Plane Coordinates of this point are: $x = 381{,}652.93$ ft., $y = 632{,}761.85$ ft.; the plane azimuths from this point to the *T.S.* and *S.T.* are 102° 26′ 15″ and 195° 42′ 39″ respectively.

Problem: To calculate a curve joining the tangents, the curve to be composed of the arc of an 8° (chord definition) circular curve joined at its ends to the tangents by 400-foot spirals.[1]

$D = 8°$

$L = 400$ ft.

$$R = \frac{50}{\sin 4°} = 716.7794 \text{ ft.}$$

$\Delta = DL/200 = 8 \times 400/200 = 16°$

$I = 180° - (195° 42' 39'' - 102° 26' 15'') = 180° - 93° 16' 24'' = 86° 43' 36''$

$$C = L\ (\cos\ 0.3\Delta + 0.004\ \text{exsec}\ \frac{3}{4}\ \Delta) = 400\ (\cos\ 4°\ 48' + 0.004\ \text{exsec}\ 12°)$$

$= 400\ (0.996\ 4929 + 0.000\ 0894) = 398.6329$ ft.

$A = \Delta/3 - 0''.00297\ \Delta^2 = 5°\ 20' - 0''.00297\ (4096) = 5°\ 19'\ 48''$

$X = C \cos A = 398.6329 \cos 5°\ 19'\ 48'' = 398.6329 \times 0.995\ 6762 = 396.909$ ft.

$Y = C \sin A = 398.6329 \sin 5°\ 19'\ 48'' = 398.6329 \times 0.092\ 8919 = 37.030$ ft.

$Z = X - R \sin \Delta = 396.909 - 716.7794 \times 0.275\ 6374 = 199.338$ ft.

$o = Y - R \text{ vers } \Delta = 37.030 - 716.7794 \times 0.038\ 7383 = 9.263$ ft.

$$T_S = (R + o) \tan \left(\frac{I}{2}\right) + Z = 726.042\ \tan\ 43°\ 21'\ 48'' + 199.338 = 726.042 \times 0.944\ 4415 +$$

$199.338 = 885.042$ ft.

### *Computation of State Plane Coordinates of Basic Points in the Curve Construction*

Plane coordinates of *T.S.* (Sta. 39 + 61.778)

$x = 381{,}652.93 - 885.042 \sin 102°\ 26'\ 15'' = 381{,}652.93 - 885.042 \times 0.976\ 5315 = 380{,}788.659$

$y = 632{,}761.85 + 885.042 \cos 102°\ 26'\ 15'' = 632{,}761.85 + 885.042 \times 0.215\ 3745 = 632{,}952.465$

---

[1] The curvature in this example is too great for most applications. It was chosen solely for the purpose of small-scale illustrations.

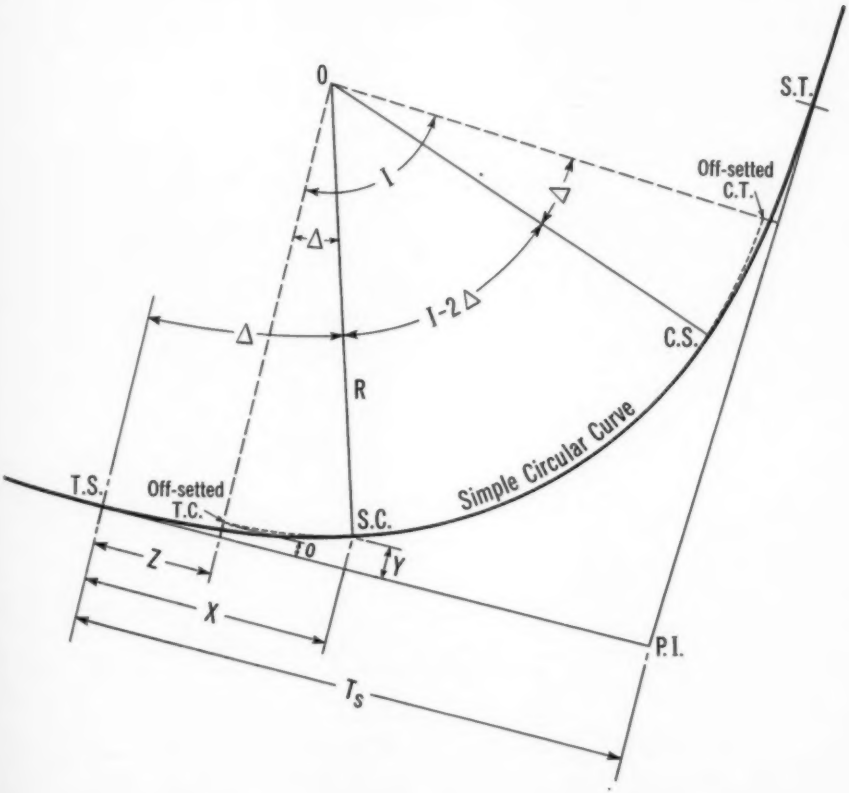
Although the elements of the curve have been rigorously computed in this example, they may be obtained to sufficient accuracy from tables. (Rubey, *Route Surveys*, Tables I and VII.)

Plane coordinates of *S.C.* (Sta. 43 + 61.778)

$(T_g - X)$ sin 102° 26′ 15″ = − 488.133 × 0.976 5315 = − 476.677
$(T_g - X)$ cos 102° 26′ 15″ = + 488.133 × 0.215 3745 = + 105.131
$Y$ sin (282° 26′ 15″ − 90° 00′ 00″) = + 37.030 × 0.215 3745 = + 7.975
$Y$ cos (282° 26′ 15″ − 90° 00′ 00″) = + 37.030 × 0.976 5315 = + 36.161
$x$ = 381,652.93 − 476.677 + 7.975 = 381,184.228
$y$ = 632,761.85 + 105.131 + 36.161 = 632,903.142

Plane coordinates of *C.S.* (Sta. 50 + 45.861)

$(T_g - X)$ sin 195° 42′ 39″ = + 488.133 × 0.270 7825 = + 132.178
$(T_g - X)$ cos 195° 42′ 39″ = + 488.133 × 0.962 6406 = + 469.897
$Y$ sin (15° 42′ 39″ + 90° 00′ 00″) = − 37.030 × 0.962 6406 = − 35.647
$Y$ cos (15° 42′ 39″ + 90° 00′ 00″) = + 37.030 × 0.270 7825 = + 10.027
$x$ = 381,652.93 + 132.178 − 35.647 = 381,749.461
$y$ = 632,761.85 + 469.897 + 10.027 = 633,241.774




Prob. V

Plane coordinates of *S.T.* (Sta. 54 + 45.861)

$T_s \sin 195° 42' 39'' = +885.042 \times 0.270\ 7825 = +239.654$
$T_s \cos 195° 42' 39'' = +885.042 \times 0.962\ 6406 = +851.977$
$x = 381{,}652.93 + 239.654 = 381{,}892.584$
$y = 632{,}761.85 + 851.977 = 633{,}613.827$

Plane coordinates of *O*

$(T_s - Z) \sin 102° 26' 15'' = -685.704 \times 0.976\ 5315 = -669.612$
$(T_s - Z) \cos 102° 26' 15'' = +685.704 \times 0.215\ 3745 = +147.683$
$(R + o) \sin (282° 26' 15'' - 90° 00' 00'') = +726.042 \times 0.215\ 3745 = +156.371$
$(R + o) \cos (282° 26' 15'' - 90° 00' 00'') = +726.042 \times 0.976\ 5315 = +709.003$
$x = 381{,}652.93 - 669.612 + 156.371 = 381{,}139.689$
$y = 632{,}761.85 + 147.683 + 709.003 = 633{,}618.536$

### *Computation of Azimuths of Chords Constituting the Spirals*

At station 39 + 61.778 (*T.S.*), α to *P.I.* = 282° 26′ 15″
At station 54 + 45.861 (*S.T.*), α to *P.I.* = 15° 42′ 39″

$$\frac{\Delta}{300} = \frac{16°}{300} = 3'.2$$

| Factors for A.R.E.A. Spiral | Difference | Diff. × 3′.2 | Azimuth of chords along spirals From *T.S.* | | | From *S.T.* | | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | 282° | 26′ | 15″ | 15° | 42′ | 39″ |
| 1 | 1 | 3′.2 | 282 | 23 | 03 | 15 | 45 | 51 |
| 7 | 6 | 19.2 | 282 | 03 | 51 | 16 | 05 | 03 |
| 19 | 12 | 38.4 | 281 | 25 | 27 | 16 | 43 | 27 |
| 37 | 18 | 57.6 | 280 | 27 | 51 | 17 | 41 | 03 |
| 61 | 24 | 1° 16.8 | 279 | 11 | 03 | 18 | 57 | 51 |
| 91 | 30 | 1 36.0 | 277 | 35 | 03 | 20 | 33 | 51 |
| 127 | 36 | 1 55.2 | 275 | 39 | 51 | 22 | 29 | 03 |
| 169 | 42 | 2 14.4 | 273 | 25 | 27 | 24 | 43 | 27 |
| 217 | 48 | 2 33.6 | 270 | 51 | 51 | 27 | 17 | 03 |
| 271 | 54 | 2 52.8 | 267 | 59 | 03 | 30 | 09 | 51 |

$$\tan \alpha\ S.C.\ \text{to}\ O = \frac{381{,}184.228 - 381{,}139.689}{632{,}903.142 - 633{,}618.536} = \frac{44.539}{-715.394}$$
$$= -0.062\ 2580$$

Azimuth *S.C.* to $O = 176° 26' 15''$
$\quad 90\ 00\ 00$
Azimuth of tangent to circular arc at *S.C* $= 266° 26' 15''$

$$\tan \alpha\ C.S.\ \text{to}\ O = \frac{381{,}749.461 - 381{,}139.689}{633{,}241.774 - 633{,}618.536} = \frac{609.772}{-376.762}$$
$$= -1.618\ 4541$$

Azimuth *C.S.* to $O = 121° 42' 39''$
Azimuth of tangent to circular arc at *C.S.* $= 211° 42' 39''$

## *Computation of State Plane Coordinates of All Stations on the Curve*[2]

### Instrument at Station T.S.

| Station | Spiral[3] def. angle | Azimuth of chord | sin | cos | Δx | Δy | State Plane Coordinates x | y |
|---|---|---|---|---|---|---|---|---|
| 61.778 (*T.S.*) | 0° 03′ 12″ | 282° 23′ 03″ | +0.976 7316 | −0.214 4654 | + 39.069 | − 8.360 | 380,788.659 | 632,952.465 |
| 01.778 | 0 12 48 | 282 03 51 | +0.977 9141 | −0.209 0070 | + 39.117 | − 8.579 | 380,827.728 | 632,943.886 |
| 41.778 | 0 28 48 | 281 25 27 | +0.980 1877 | −0.198 0708 | + 39.208 | − 7.923 | 380,866.845 | 632,935.526 |
| 81.778 | 0 51 12 | 280 27 51 | +0.983 3687 | −0.181 6206 | + 39.335 | − 7.265 | 380,906.053 | 632,927.603 |
| 21.778 | 1 20 00 | 279 11 03 | +0.987 1804 | −0.159 6084 | + 39.487 | − 6.384 | 380,945.388 | 632,920.338 |
| 61.778 | 1 55 11 | 277 35 03 | +0.991 2520 | −0.131 9825 | + 39.650 | − 5.279 | 380,984.875 | 632,913.954 |
| 01.778 | 2 36 47 | 275 39 51 | +0.995 1175 | −0.098 6974 | + 39.805 | − 3.948 | 381,024.525 | 632,908.675 |
| 41.778 | 3 24 45 | 273 25 27 | +0.998 2147 | −0.059 7274 | + 39.929 | − 2.389 | 381,064.330 | 632,904.727 |
| 81.778 | 4 19 06 | 270 51 51 | +0.999 8863 | −0.015 0820 | + 39.995 | − 0.603 | 381,104.259 | 632,902.338 |
| 21.778 | 5 19 48 | 267 59 03 | +0.999 3811 | +0.035 1757 | + 39.975 | + 1.407 | 381,144.254 | 632,901.735 |
| 61.778 (*S.C.*) | | | | | +395.570 | − 49.323 | 381,184.229 | 632,903.142 |
| rk | | | | | | | 381,184.228 | 632,903.142 |
| gnt to arc at *T.S.* | | 266° 26′ 15″ | | | | | | |

### Instrument at Station S.C.[4]

| | Circular def. angle | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 61.778 (*S.C.*) | 3° 21′ 45″ | 263° 04′ 30″ | +0.992 7048 | +0.120 5700 | + 83.470 | + 10.138 | 381,184.228 | 632,903.142 |
| 45.861 | 7 21 45 | 255 42 45 | +0.969 0696 | +0.246 7876 | + 96.907 | + 24.679 | 381,267.698 | 632,913.280 |
| 45.861 | 11 21 45 | 247 42 45 | +0.925 2925 | +0.379 2543 | + 92.529 | + 37.925 | 381,364.605 | 632,937.959 |
| 45.861 | 15 21 45 | 239 42 45 | +0.863 5056 | +0.504 3392 | + 86.351 | + 50.434 | 381,457.134 | 632,975.884 |
| 45.861 | 19 21 45 | 231 42 45 | +0.784 9116 | +0.619 6078 | + 78.491 | + 61.961 | 381,543.485 | 633,026.318 |
| 45.861 | 23 21 45 | 223 42 45 | +0.691 0401 | +0.722 8164 | + 69.104 | + 72.282 | 381,621.976 | 633,088.279 |
| 45.861 | 27 21 45 | 215 42 45 | +0.583 7184 | +0.811 9562 | + 58.372 | + 81.196 | 381,691.080 | 633,160.561 |
| 45.861 (*C.S.*) | | 211 42 45 | | | +565.224 | +338.615 | 381,749.452 | 633,241.757 |
| k | | | | | | | 381,749.461 | 633,241.774 |
| gnt to arc at *C.S.* | | 211° 42′ 39″ | | | | | | |

### Instrument at Station S.T.

| rd ∠s run ward from (*S.T.*) | Spiral[3] def. angle | | | | | | |
|---|---|---|---|---|---|---|---|
| 45.861 (*C.S.*) | | | | | | | 381,749.461 | 633,241.774 |
| 45.861 | 5° 19′ 48″ | 30° 09′ 51″ | +0.502 4793 | +0.864 5892 | + 20.099 | + 34.584 | 381,769.560 | 633,276.358 |
| 45.861 | 4 19 06 | 27 17 03 | +0.458 4040 | +0.888 7439 | + 18.336 | + 35.550 | 381,787.896 | 633,311.908 |
| 45.861 | 3 24 45 | 24 43 27 | +0.418 2502 | +0.908 3318 | + 16.730 | + 36.333 | 381,804.626 | 633,348.241 |
| 45.861 | 2 36 47 | 22 29 03 | +0.382 4281 | +0.923 9852 | + 15.297 | + 36.959 | 381,819.923 | 633,385.200 |
| 45.861 | 1 55 11 | 20 33 51 | +0.351 2562 | +0.936 2794 | + 14.050 | + 37.451 | 381,833.973 | 633,422.651 |
| 45.861 | 1 20 00 | 18 57 51 | +0.324 9768 | +0.945 7220 | + 12.999 | + 37.829 | 381,846.972 | 633,460.480 |
| 45.861 | 0 51 12 | 17 41 03 | +0.303 7698 | +0.952 7455 | + 12.151 | + 38.110 | 381,859.123 | 633,498.590 |
| 45.861 | 0 28 48 | 16 43 27 | +0.287 7645 | +0.957 7012 | + 11.511 | + 38.308 | 381,870.634 | 633,536.898 |
| 45.861 | 0 12 48 | 16 05 03 | +0.277 0491 | +0.960 8558 | + 11.082 | + 38.434 | 381,881.716 | 633,575.332 |
| 45.861 (*S.T.*) | 0 03 12 | 15 45 51 | +0.271 6784 | +0.962 3881 | + 10.867 | + 38.496 | 381,892.583 | 633,613.828 |
| k | | | | | +143.122 | +372.054 | 381,892.584 | 633,613.827 |

[2] In this example more decimal places have been used than would ordinarily be used in practice. This was done to furnish a close mathematical check on the computation.

[3] The spiral deflection angles may either be computed rigidly from the equations in Rubey's *Route Surveys* or may be taken from Table IX of the same volume.

[4] The first chord from Station 43 + 61.778 (*S.C.*) to Station 44 + 45.861, is 84.083 feet long. All others on the circular curve are 100 feet long.

# An Examination of the Estimation of Tenths by Different Observers

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## INTRODUCTION

IT HAS BEEN KNOWN for many years, and has been pointed out frequently in text books dealing with the theory of measurement, that different experienced observers in their subjective estimations of tenths of scale divisions are partial to certain numbers and have an apparent aversion to others. For instance, some observers seldom estimate 0.0, as they are inclined to be too conscious of displacements of the index from a graduation line, and hence have a tendency towards recording too many estimations of 0.9 and 0.1 division. Others have a dearth of 0.5's, as they are oversensitive to the ratio of the unequal areas when the index is near the centre of the division, and consequently estimate 0.4 and 0.6 too frequently.

## HISTORICAL

Investigations of this kind probably had their beginning early in the nineteenth century when Bessel (4) in 1822 initiated an intensive series of experiments on the subjective estimation of time passages in astronomical observations. About 25 years prior to this time, Maskelyne of Greenwich Observatory had discovered that one of his helpers repeatedly estimated time passages from 0.5 to 0.8 second later than he himself did, and in consequence of this had dismissed his assistant (1). But Bessel was able to show that such systematic differences existed among some of the leading astronomers of that era, and that, moreover, these differences remained sensibly constant for years on end.

To simplify the experimental investigation of the phenomena, Boquet in 1890 and later Bäckström in 1928 (1, 2, 3) employed fixed scales to test the performance of groups of observers. For his experiments, Bäckström prepared a series of 100 cards, on each of which was drawn a single scale division with an intermediate index marker, the position of which was first determined by direct measurement to the nearest 0.01 division. The entire series formed an arithmetic progression ranging from 0.00 to 0.99 division. Each participant in the test then estimated the position of the index on every card to the nearest tenth of a division, going through the complete series ten times, with a different permutation each time. It was found that a given observer had a distinctive preference for certain numbers and a decided aversion for others (which varied among the observers), and that, in general, in each of the ten series the same tenth was called an approximately equal number of times.

Using these cards and others somewhat similar but with various sizes of graduations, index markers, colorations of the two portions of the division, etc., Bäckström was able to conduct many experiments from which he drew certain conclusions which are discussed in his reports (1, 2, 3).

Birch and MacDonald (5) have carried on other investigations in which the position of a moving index was estimated on a galvanometer scale.

## NATIONAL RESEARCH LABORATORIES INVESTIGATIONS

The Metrology section of the National Research Laboratories has in its files test data relating to certain physical measurements extending as far back as 30 years. Some of these measurements involve one or two thousand estimations of micrometer drum indications, and have been repeated at intervals over the years with all major conditions of the experiment remaining unchanged. It was felt that an examination of these records might yield some interesting information insofar as the personal tendencies of these skilled observers for estimating tenths are concerned. From a practical point of view there is the advantage that, in contrast with the work of Boquet and Bäckström, the subjects were quite unaware that their efforts might later

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provide the basis for an investigation of this kind. Moreover, all the data have been obtained under actual operating conditions, and hence are not affected by any artificial characteristics which might obscure the findings.

It has been possible to compare the performance of different observers who have participated in these tests, and in addition, in some cases, to study the relative performances of the same observer at different times. There are also available series of estimations which have been made by observers using different instruments.

In most of the experiments concerned, the micrometer drums are part of a length comparator employed in the comparison of line standards of length. In order to minimize periodic errors of the micrometer screws, readings are taken at several approximately equal intervals around the periphery of the drum, the standards being moved longitudinally between readings. In this way, the estimations are entirely random, a condition requisite for a subjective investigation of this kind.

The records of six observers have been analyzed and from these records the pertinent information has been extracted to yield characteristic curves for each observer.

## DISCUSSION OF THE CHARACTERISTIC CURVES

Actually, in each single test or investigation, the total number of estimated tenths was counted for each of the digits from 0 to 9 respectively, and the relative frequency of occurrence of each was found by dividing the ten totals, in turn, by the aggregate of all the readings. Graphs were then plotted, with the relative frequencies as ordinates and with the actual tenths of scale division as abscissas. Thus, an observer possessing no personal bias whatsoever towards any digit, i.e., a reader who estimates each tenth an equal number of times during an extended series of observations, would have his characteristic performance represented by a straight line with a constant ordinate of 0.1. An observer who rarely calls a certain number, say 0.5, would then be characterized by a frequency curve with a decided dip in this zone of 0.5's, and a compensating rise elsewhere.

For instance, the frequency curves of Observer A (fig. 1) show this trait which is also common to the estimated 0.3's and 0.7's. The readings on which this graph is based were obtained by A (using the length comparator to compare meter line standards) in June, 1948. The plot with the solid line was derived from 1,447 observations which were made during the first half of the experiment, while the dotted line represents 1,439 pointings from the second half of the same test. It will be seen that, although the amplitudes of the variations of the first graph are slightly

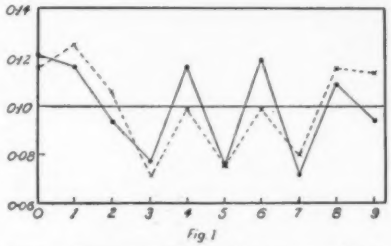


Fig 1

*Fig. 1.* — Frequency distribution of estimated tenths of a scale division, based on readings of Observer A. In this and the following diagrams the abscissas are tenths of a scale division and the ordinates are the relative frequency of occurrence. An ordinate of 0.10 represents one-tenth the total number of observations in a particular series.

● . . . . . plotted from 1447 readings, June, 1948
× . . . . . plotted from 1439 readings, June, 1948

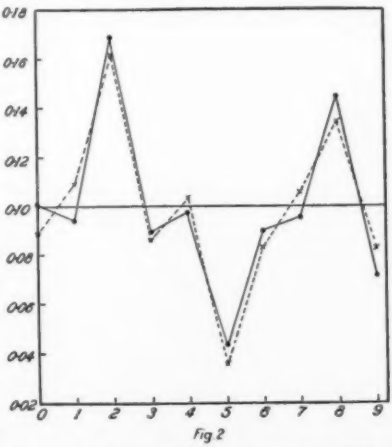


Fig 2

*Fig. 2.* — Frequency distribution based on readings of Observer B.

● . . . . . plotted from 1391 readings, November, 1938
× . . . . . plotted from 1206 readings, November-December, 1938.

greater than those of the second, the peaks and valleys of both appear to be sensibly at the same respective positions.

Figure 2 shows how Observer B estimated his readings which had been obtained a few years prior to A's, in 1938, the same experimental apparatus and procedure being used by both. A comparison of the two sets of curves shows that A's variations are smaller and more regular than B's, which latter, nevertheless, are consistent with each other. A lack of 0.5's and a preponderance of 0.2's and 0.8's are evident in B's case.

The interesting feature of figure 3 is the change in a particular observer's frequency curve over a number of years. Two of the sets of observations concerned were made in 1927, while the remaining two were made 7 to 9 years later. In each case, the relevant plots are consistent with each other, but during the 9-year interval the amplitudes have decreased somewhat, although the positions of the hills and valleys are unchanged. This observer was especially partial to 0.0's.

The two traces in figure 4 were obtained from pointings made 5 years apart by Observer D. The interesting aspect here is that the readings on which these graphs are established were taken in different countries and with different instruments. The similarity of the graphs is very evident, showing that this investigator's pattern had not varied appreciably either with time or environment (i.e., using different instruments).

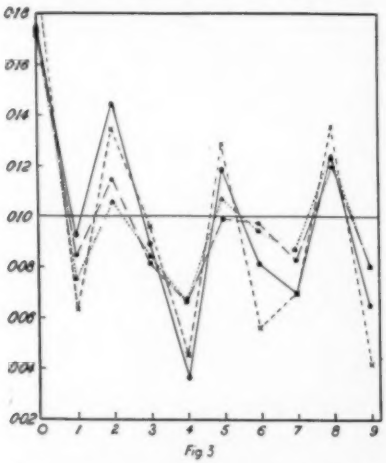


Fig 3

*Fig. 3.* — Frequency distribution based on readings of Observer C.

● . . . . . plotted from 1566 readings, November, 1926 - January, 1927
× . . . . . plotted from 1782 readings, March-July, 1927
■ . . . . . plotted from 2640 readings, August-September, 1934
▲ . . . . plotted from 2463 readings, August-September, 1936.

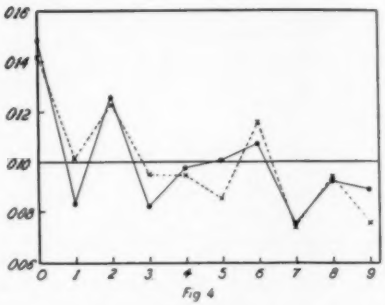


Fig 4

*Fig. 4.* — Frequency distribution based on readings of Observer D, using two different instruments.

● . . . . plotted from 2502 readings, Paris, June-July, 1929
× . . . . plotted from 3700 readings, Ottawa, February, 1934.

In figure 5, the full and dotted lines are representative of readings made by Observer E using the Canadian 1-meter comparator in 1926. The curves, as in the previously discussed cases, are again similar to each other and are characteristic of the reader who exhibits a paucity of 0.3's, 0.4's, 0.5's, 0.6's and 0.7's. The other plot with the broken line (short and long dashes) is based on pointings of the same observer but with an entirely different instrument, in which angular intervals were measured by micrometric means. The general trend of this latter curve to follow the two derived from 1-meter comparator readings appears to be unmistakable.

The performance curves of Observer F showing a marked preference for 0.3's and an apparent bias against 0.0's and 0.9's are seen in figure 6.

## ESTIMATION BANDS

In any sufficiently large number of random readings, each estimated tenth, if correctly called, should occur an equal number of times. This arises from the fact that throughout the series, the actual position of the index marker should fall an equal number of times in each of the zones

0.95 to 0.05 division, 0.05 to 0.15, etc. An unbiased or perfect observer, then, would consider any reading falling in a particular zone to be that tenth associated with the zone, i.e., readings lying between 0.95 and 0.05 would be adjudged as 0.0, those between 0.05 and 0.15 as 0.1 and so on. Since perfect observers of this type are rare, if they exist at all, it is reasonable to suppose that if a certain estimated tenth be called, say 8 percent of the total number of pointings, the observer is prone to name that tenth only when the index lies in a corresponding zone which is 0.08 division wide, instead of 0.10 division. There must, of course, be a compensating oversize zone elsewhere in the total scale interval, making the final mean 0.10 division for each tenth.

Referring again to figure 1 (using the mean of the two curves), if this reasoning be followed, then Observer A, in estimating 0.0 twelve percent of the time, can be assumed to have a band width or zone of 0.12 scale division for that particular tenth. If, further, the centre of his band coincides with the graduation line, he would consider all readings actually falling within 0.94 and 0.06 to be 0.0. There is, of course, no available evidence that the centre of his 0.0 band is in phase with the graduation, but with this assumption and with the next 12 percent of his readings designated as 0.1, the band width for 0.1 would be 0.12

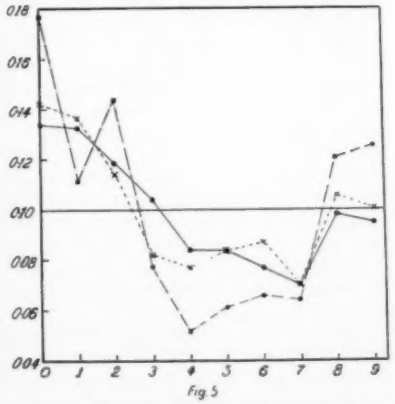


Fig. 5

*Fig. 5.* — Frequency distribution based on readings of Observer E, using two different instruments.
● . . . . plotted from 1154 readings, July-October, 1926
× . . . . plotted from 1056 readings, December, 1926
■ . . plotted from 1380 readings, March, 1926.

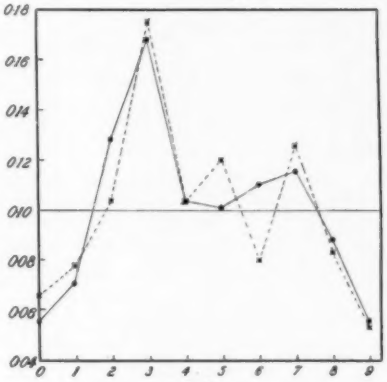


Fig 6

*Fig. 6.* — Frequency distribution based on readings of Observer F.
● . . . . . plotted from 2072 readings, October, 1926 - January, 1927
× . . . . plotted from 1152 readings, October-November, 1927.

and would extend from 0.06 to 0.18 division, and so on. This is graphically depicted in figure 7 (A) in which the contiguous and equal areas below the central horizontal line represent the band patterns of an unbiased or perfect observer, while those areas above the line pertain to A's readings. In order to distinguish adjacent bands from each other more easily in this and the following diagrams, the zones associated with odd tenths have been shaded.

There are several features in this particular diagram (fig. 7A) worth noting. Since the 0.3's and the 0.5's lie entirely within the ideal bands of 0.25 to 0.35 and 0.45 to 0.55 respectively, any reading which A calls 0.3 or 0.5 would not be in error; his estimations of 0.2, however, apparently cover a range from 0.18 to 0.28 division, and hence it would be expected that about one-third of his 0.2 estimations should rightly be called 0.3; and his 0.0's which lie within the factual band of 0.94 and 0.06 would, for the most part, be actually 0.0, but in about 20 percent of the cases could be 0.9 or 0.1.

With similar reasoning one could say that B (see fig. 7B) is not incorrect whenever he reads 0.0, 0.1, 0.5, 0.6 or 0.9, but each of the remaining estimated tenths might be actually one of two consecutive integers.

Figures 7 (C) to 7 (F) are respectively

associated with figures 3 to 6, in the same way as figures 7 (A) and 7 (B) are with figures 1 and 2. As has been pointed out previously, it has been assumed in the compilation of these diagrams, that the experimenters read symmetrically about the graduation line. Bäckström, in his experiments on symmetrical scales, found that the subjective division of the scale interval was symmetrical about the graduation, and about the imaginary centre of 0.5 line as well. In addition, his investigations revealed that the estimated 0.1's and 0.9's were approximately equal in quantity as were the 0.2's and 0.8's, etc. In the case of the Canadian observers this latter feature was found to be generally true, with the exception of F (fig. 6) whose dissymmetry is decidedly evident. Moreover, only two observers, A and E, had estimation bands or areas symmetrical about both the 0.0 and the 0.5 line, as a re-examination of figure 7 will show. How marked this dissymmetry actually is, in the case of F, can be seen in figure 7 (G) in which the centre of the estimated 0.5 band has been made to coincide with the true 0.5 line. Here all readings which F believes to be 0.1 would, under these circumstances, fall between 0.98 and 0.05 and hence would actually be 0.0.

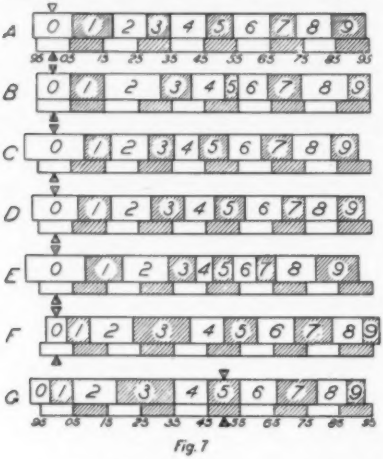


*Fig. 7*

*Fig. 7.* — Subjective division of a scale interval into tenths by Observers A to F.

A. . . . . Observer A, based on the mean of the plots, fig. 1, and with the centre of the observer's 0.0 band made coincident with the graduation line.
B. . . . . Observer B, based on the mean of the plots, fig. 2.
C. . . . . Observer C, based on 2463 readings, fig. 3.
D. . . . . Observer D, based on 3700 readings, fig. 4.
E. . . . . Observer E, based on 1380 readings, fig. 5.
F. . . . . Observer F, based on 2072 readings, fig. 6.
G. . . . . Observer F. The same observations as in F, but with the centre of the observer's 0.5 band width made coincident with the 0.5 point of the scale division.

## REMARKS

Although the dissimilarity of the individual performance curves would, at first glance, seem to be rather large, actually none of the observers could be called an unsatisfactory estimator, for if the particular estimation band diagrams are examined, it will be seen that in no case is any single estimation in error by more than 0.1 division, and that generally the discrepancy is less than 0.05 division. This has been found to hold true whether the observers' estimations are symmetrical about the 0.0 or the 0.5 line. One might expect, then, that any two of these observers, in simultaneously estimating a reading, would agree to considerably better than 0.1 division, except in those cases where conditions are favourable for one of the readers to estimate too high and the other too low. This could occur when Observers E and F view an index truly positioned at 0.70. This would fall within E's zone of 0.8's (fig. 7E) and within F's band of 0.6's (fig. 7F), and would be respectively called by each, 0.8 and 0.6.

This condition could arise in the verification of liquid in glass thermometers immersed in a bath, the control temperature of which is measured by means of an indicating instrument such as a resistance thermometer and associated resistance bridge; it could also be encountered in calibrating hydrometers against hydrostatic weighings. In the case of the thermometers, experienced observers are usually able to repeat their own readings (if the temperature of the bath remain constant) to a remarkable degree of precision, i.e., much better than 0.05 division, but the differential among observers in estimating at certain portions of the scale division may, at times, be considerable. In comparator tests, on the other hand, such an event would be inconsequential, as differences, rather than absolute values, are sought, and hence personal errors are minimized, if not eliminated.

SUMMARY

1. The records of the estimations of six experienced observers have been studied, and from the data, graphs have been plotted to show the relative frequency of occurrence of estimated tenths of scale divisions for each observer. In addition, diagrams showing the subjective division of the scale interval have been drawn for each observer.

2. It has been found that each observer possesses a personal bias for or against calling certain numbers.

3. In the case of two observers, from whose records the necessary information could be extracted, it was seen that these personal tendencies persisted throughout the years.

4. In no case did any of the observers appear to be in error by more than 0.1 division in his estimations, and generally the discrepancy was less than 0.05 division.

ACKNOWLEDGMENT

The authors are very indebted to R. H. Field, head of the Metrology Section, who suggested this investigation and who gave valuable advice during the preparation of the paper. They also wish to thank F. D. Pearson, of the Metrology Section, who extracted from the records the data from which the graphs were plotted.

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# Navigation Device Tells Distance to Destination

A NAVIGATIONAL DEVICE that automatically tells pilots not only where they are, but exactly how far they are from their destination and the direction in which to proceed to reach it, has been developed by Capt. Robert Jasperson, U. S. Navy (Retired).

"While designed primarily for use in high-speed aircraft, the system may be employed in surface craft, or to fix the position of any point on the earth's surface," Capt. Jasperson reported at the Institute of Navigation meeting in Annapolis.

Developer of an automatic pilot that uses true celestial navigation to hold a guided missile to its course, Capt. Jasperson reports that once his new device has been set on two stars, the system will continue to function although one or both stars may be obscured temporarily.

The Jasperson device is based primarily upon the Zerbee Celestial Fix Finder. This instrument for solving several spherical triangles simultaneously was patented by Louis J. Zerbee of Bellefontaine, Ohio, in August, 1950. The Zerbee device uses the declination, Greenwich hour angle, and altitude of two selected celestial bodies to get instantaneously the observer's longitude and latitude at a given instant. The observer's position is accurately located within a mile.

Two additional factors are incorporated in Captain Jasperson's device. One gives the latitude and longitude of the pilot's destination, the other mechanically joins the plane's present position with his destination. The plane's course and distance from its point of destination are determined instantly.

To eliminate the bothersome task of manually setting the stars' declination and sidereal hour angle each time the fix finder is used, Captain Jasperson incorporates two star viewers to simulate the apparent motions of the chosen stars. These must be checked from time to time, of course, to be sure the selected stars are centered in the viewer.—*Science News Letter*, March 29, 1952.

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# Topographic Mapping Along the National System of Interstate Highways[1]

*(A Panel Discussion)*

DISCUSSANTS:

J C Carpenter, Bureau of Public Roads, *Moderator*
Capt. Henry W. Hemple, U. S. Coast and Geodetic Survey
Col. John G. Ladd, Army Map Service
Robert H. Lyddan, U. S. Geological Survey
Harold F. Clemmer, District of Columbia Government

## Introduction

*By* J C CARPENTER
SUPERVISING HIGHWAY TRANSPORT RESEARCH ENGINEER, U. S. BUREAU OF PUBLIC ROADS

In order to secure a satisfactory alignment of our country roads it is extremely desirable to have good topographic maps of the field which is to be traversed. The maps must give in a clear way all the topographic features of the district; the lay of the streams in relation to each other, and the slope of the surfaces which compose the area are essential features in such a map. Until the present decade no such maps have existed in this country, except, perhaps, in small areas about our great cities and at certain points in the shore belt which have been charted by the United States Coast Survey. The United States Geological Survey is now engaged in making a map of the whole country, which, though designed for geological purposes, will afford great help to our rural population in determining the fittest position for their ways of communication. With a good topographic map of this description in hand, it is possible to plot a projected road in such a manner as to secure a minimum grade between the points which it is intended to connect.

The above paragraph is quoted from an article entitled "Common Roads" by N. S. Shaler, Professor of Geology, Harvard University, published in *Scribner's Magazine* for October 1889.

The maps contemplated in the program of 1889 were partly completed and no doubt many of them are still in use. The 60 years of intensive development of the country have changed the requirements for maps, and highway engineers responsible for the location of expensive thoroughfares need better maps than were then contemplated. These old maps have been of inestimable value in the development of the country and there is no doubt that the quality of the information shown on them was as high as, or higher than, the requirements of the time they were prepared. Some of the constantly recurring complaints about this series of maps are that they are not accurate, the scale is too small and, because of their age, the culture and improvement data are not complete and up to date.

In the introduction to House Document No. 706, 81st Congress, Second Session, which is entitled "A Program to Strengthen the Scientific Foundation in Natural Resources," Senator Joseph C. O'Mahoney, Chairman, Senate Committee on Interior and Insular Affairs, says:

> It is our task, as legislators, to become familiar with all the problems of land use. The best use of each kind of soil and of the land surface can be discovered only when they are measured and charted, and full knowledge of their nature and constituency is available in detail. The surveying and mapping of lands,

[1] A topic for discussion at the meeting of the Technical Division on Topography of the American Congress on Surveying and Mapping, June 20, 1951.

including the continental shelves extending into the oceans, must necessarily be sufficiently detailed to show the elevation, the thicknesses, and the physical features and the mineral content of the geological formations comprising the lithosphere. The data will permit their classification for their best use and the evaluation of the minerals and other materials they contain. Thus the program for mapping, the need for which is explained herein, will result in a three-dimensional description of that portion of the earth's crust which is of most immediate concern for our economic progress and national security.

In the same Document Congressman J. Hardin Peterson, Chairman, Committee on Public Lands of the House of Representatives, also says:

> The logical starting points for most Federal and non-federal projects in a wide variety of natural resources are suitable maps. Yet these are often not available. Our mapping programs are generally proceeding so slowly that, at the current rate of progress, it will require from 40 to 100 years for their completion. There is universal recognition that nothing would contribute more to an effective and judicious development of our resources and the economical operation of our many activities than a complete set of maps showing the necessary surface and subsurface features. Such maps are necessary for the effective development of our mineral and water resources, the effective use of our soils, the location of highways, railways, dam sites, industrial plants, telephone and electric lines, radio transmission stations, airports, reclamation projects, drainage projects, and almost all activities dealing with the surface of the earth and the development of its resources. The effective use of the soil in the production of farm crops, timber production, and other useful plant life can best be understood and carried out with suitable maps available.
>
> Military needs are no less important than peacetime economic needs and are actually almost identical with these since military might depends upon strong economic and industrial institutions and activities, and these are everywhere dependent upon effective use of natural resources.

There is little doubt that modern accurate mapping will be carried on in the immediate future at an accelerated pace, as compared to the record of the past century. The highway industry, with its large responsibility for providing facilities for public transportation, will profit from the mapping program in direct proportion to the interest shown by its executives in outlining the essential needs of the highway engineering profession to the officials in charge of the mapping activities. The priority of need of the maps for highway projects must be determined by the engineers and executives of the State and Federal agencies responsible for programs of highway expenditures and for long-range planning of the highway business.

The highways comprising the National System of Interstate Highways have been selected in compliance with the provisions of the Federal-Aid Act of 1944. They serve the most populous areas of the country and the sections where there is now or will be the most intensive industrial and commercial development. Completion of mapping in the areas adjacent to this system will be most valuable to the majority of the people and in the economic development of our resources. (*See* fig. 1.)

Quotations from two highway engineers seem appropriate at this point. Mr. Curtis J. Hooper of Connecticut, at the January meeting of the American Society of Photogrammetry, said, ". . . to my amazement, I found that only a small percent of this country had been mapped by the United States Geological Survey. Connecticut had such maps fifty years ago, and ten years ago the process was repeated at a better scale; within a few years we will have complete coverage of the State. The scale of the maps is 1:31,680 and the contour interval is 10 feet. Our use of photogrammetry in Connecticut starts from that."

At this same meeting, Mr. E. C. Houdlette of Massachusetts gave the experience of that State as follows: "Until 1934 the



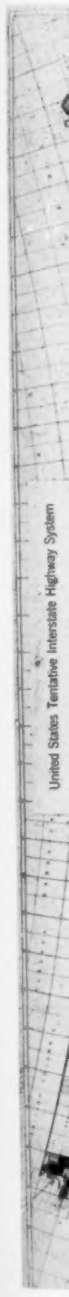


FIGURE 1.—United States tentative Interstate Highway System.

only topographical maps of Massachusetts that were available were those made by the U. S. Geological Survey in 1886, scale 1:62,500. These maps had had so few revisions and were so full of inaccuracies that they were of little value for reconnaissance studies." The Massachusetts Legislature authorized the remapping of the State through a cooperative agreement between the Massachusetts Department of Public Works and the U. S. Geological Survey. Mr. Houdlette continued: "We now have modern Geological Survey maps available for the entire Commonwealth. These maps are at a scale of 1:31,680 and have a contour interval of 10 feet. With these maps it is possible to determine the horizontal position of any point within 65 feet and to find its elevation with an error not exceeding 10 feet, with 90 percent of the points within 5 feet of the correct elevation."

On sections of the National System of Interstate Highways, the location of the highway and the type of construction have been developed to a high standard that will not need to be changed for some time. Along other sections, such as through Connecticut and Massachusetts and some areas of other states, modern topographic maps are now available which will serve the essential requirements of highway engineers. Obviously, on these sections there will be no immediate necessity for revision of the maps now available, so far as the requirements of the highway industry are concerned. Highway administrators will be charged with the responsibility of making their requirements known in advance, so that the mapping agencies may take these needs into consideration in planning future work. For example, the mapping requirements along the Pennsylvania-New Jersey Interstate Highway System are shown in figure 2.

In the extension of geodetic control, the best service to highway development will be provided if the Coast and Geodetic Survey is notified in advance of project construction as to the locations where control will be most helpful. This will provide an opportunity for the Survey to fit the highway requirements into their future programs of work. Geodetic stations may then be located within economic reach of the highway surveys and, incidentally, the highway surveys, when accurately executed, will provide supplemental control for future topographic mapping. Close cooperation between responsible highway authorities and the planning officials of the Coast and Geodetic Survey will result in mutual benefit to both organizations.

Similarly, in scheduling topographic mapping the U. S. Geological Survey should know the needs of the highway engineers so that they may plan their operations to benefit the highway programs. One element of this procedure is very important from an economic viewpoint, namely, the determination of a scale that will make the maps suitable for highway location.

In selecting the routes for the National System of Interstate Highways, thorough consideration was given to their location in relation to military and naval establishments and to war industries. The system is designed to bear a very large share of the longer highway traffic to and from the military and naval establishments of the country. Accordingly, the Defense Department will have a large interest in the programs of improvement along the routes of this system.

In suggesting the development of a program of mapping along the system of Interstate Highways, there is no intention of discrediting the mapping of rural areas not touched by the system. Highway administrators will profit through close collaboration with mapping agencies so that highway needs may be properly met in any areas where mapping is underway. Development of modern maps along the Interstate System will provide samples of a good product that will sell itself and create a demand for better mapping throughout the entire country.

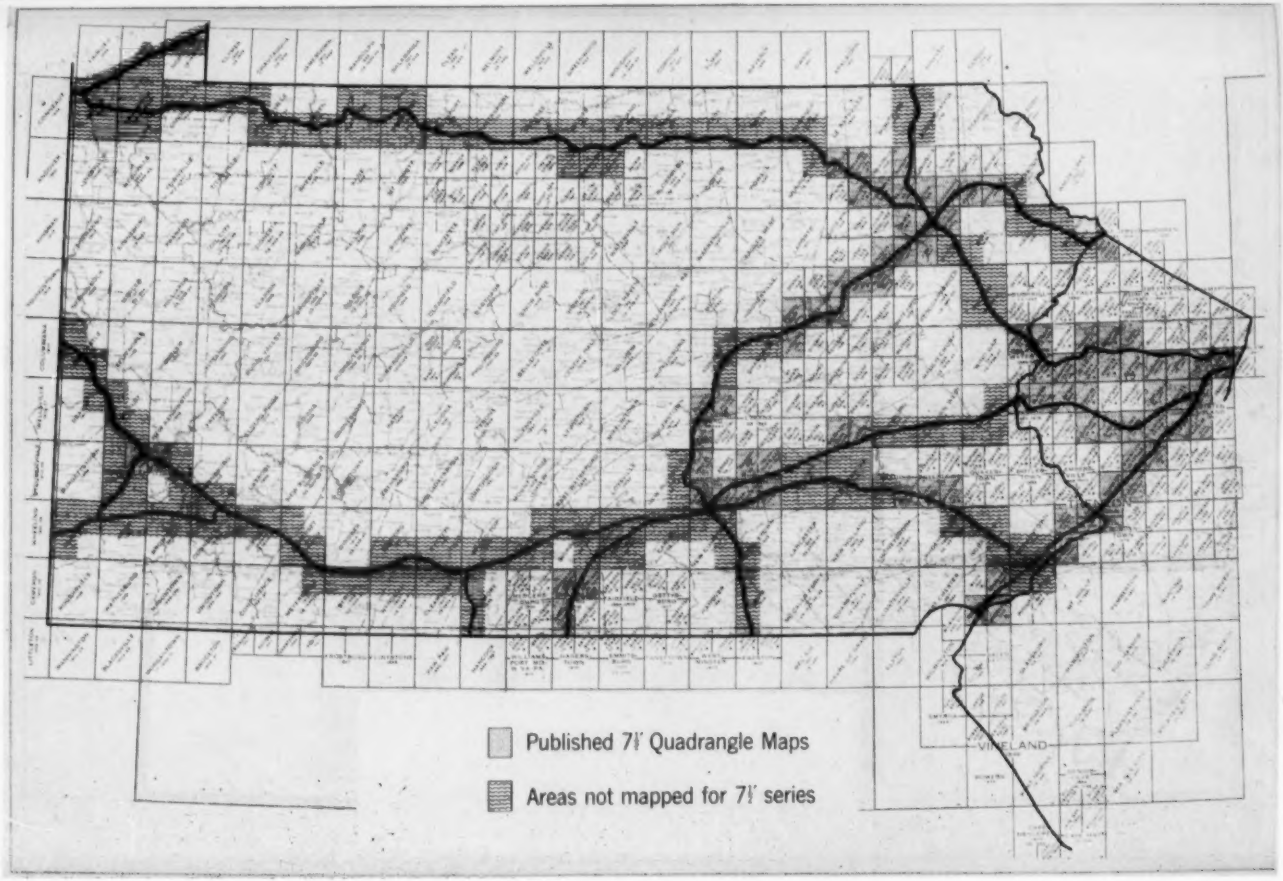



FIGURE 2.—Pennsylvania–New Jersey tentative Interstate Highway System.

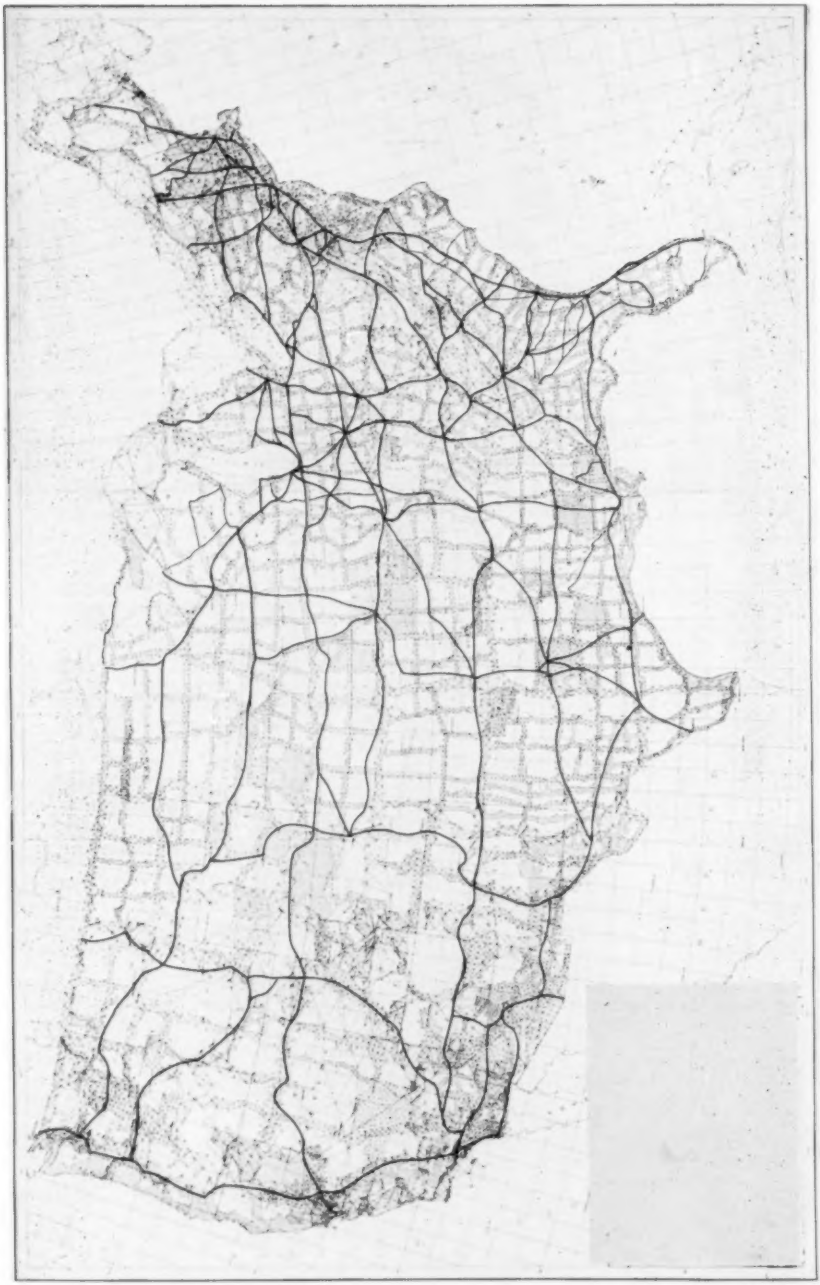


FIGURE 3.—Triangulation net of the United States with superimposed National System of Interstate Highways.

# Control Survey Requirements

*By* CAPT. HENRY W. HEMPLE
CHIEF DIVISION OF GEODESY, U. S. COAST AND GEODETIC SURVEY

IN PLANNING for nation-wide engineering projects such as the National System of Interstate Highways, a logical requirement is that the surveys and maps concerned therewith be coordinated. Various details of the topography are shown in their correct position relative to one another on adequately controlled maps. Studies of physical characteristics may then be made for the area as a whole and the most suitable locations for highways selected. Without such control, gaps or overlaps occur between contiguous local surveys and confusion is certain to result. The use of survey control points enables highway construction to start at various places along the route, no matter how widely separated, with assurance that a correct junction of all construction lines will be effected.

The means of this coordination is available through the fundamental geodetic surveys of the Coast and Geodetic Survey. These surveys consist of triangulation to determine latitude, longitude, and azimuths for marked points and prominent objects, and of leveling to determine the elevation of bench marks. The Federal triangulation network is expressed on one datum and the bench marks have their elevations determined with reference to mean sea level, so that maps and surveys based on the Federal control network are shown in their correct horizontal and vertical relationships, each to the others. Conclusive decisions and plans can, therefore, be made relative to large engineering projects.

At the present time the Coast and Geodetic Survey has about 120,000 miles of triangulation and about 380,000 miles of precise leveling lines in the United States. Our present policy in extending geodetic surveys in any locality is to provide a minimum of one triangulation station for each 7½-minute mapping quadrangle. In addition, monumented triangulation points are established at about 4-mile intervals along the major highways. Our policy as to leveling is to space the lines about 6 miles apart with bench marks set at 1-mile intervals along each line. It is our opinion that the breakdown beyond the spacing mentioned above is the function of the local engineer and surveyor.

The triangulation and leveling control has already been established for many areas of the proposed National System of Interstate Highways and is available for use of the map maker and for the engineer in the construction of the highways. Of the 38,700 miles in the proposed National System of Interstate Highways, about 11,350 miles have nearby arcs of first- and second-order triangulation. (*See* fig. 3.) There are 26,450 miles where no control is now in close proximity. With our present appropriations we complete about 4,500 miles of triangulation per year. Just to establish triangulation surveys along unsurveyed areas for the proposed Interstate Highway System would, if we devoted our entire efforts to the highway needs, take 6 years at the present rate of progress.

The situation as regards leveling is more fortunate. Most of the routes of the proposed National System of Highways follow existing roads along which precise leveling has been accomplished. Only 2,000 miles of the proposed 38,700 miles of highway do not have level lines of either first- or second-order accuracy. (*See* fig. 4.) As our average yearly rate of leveling is 7,500 miles, the completion of the remainder for which elevations are not now available is not too great a problem.

The program of control surveys of the Coast and Geodetic Survey is planned on the basis of requests from Federal bureaus, such as the Geological Survey, Forest Service, Corps of Engineers; State, county, and municipal organizations; and

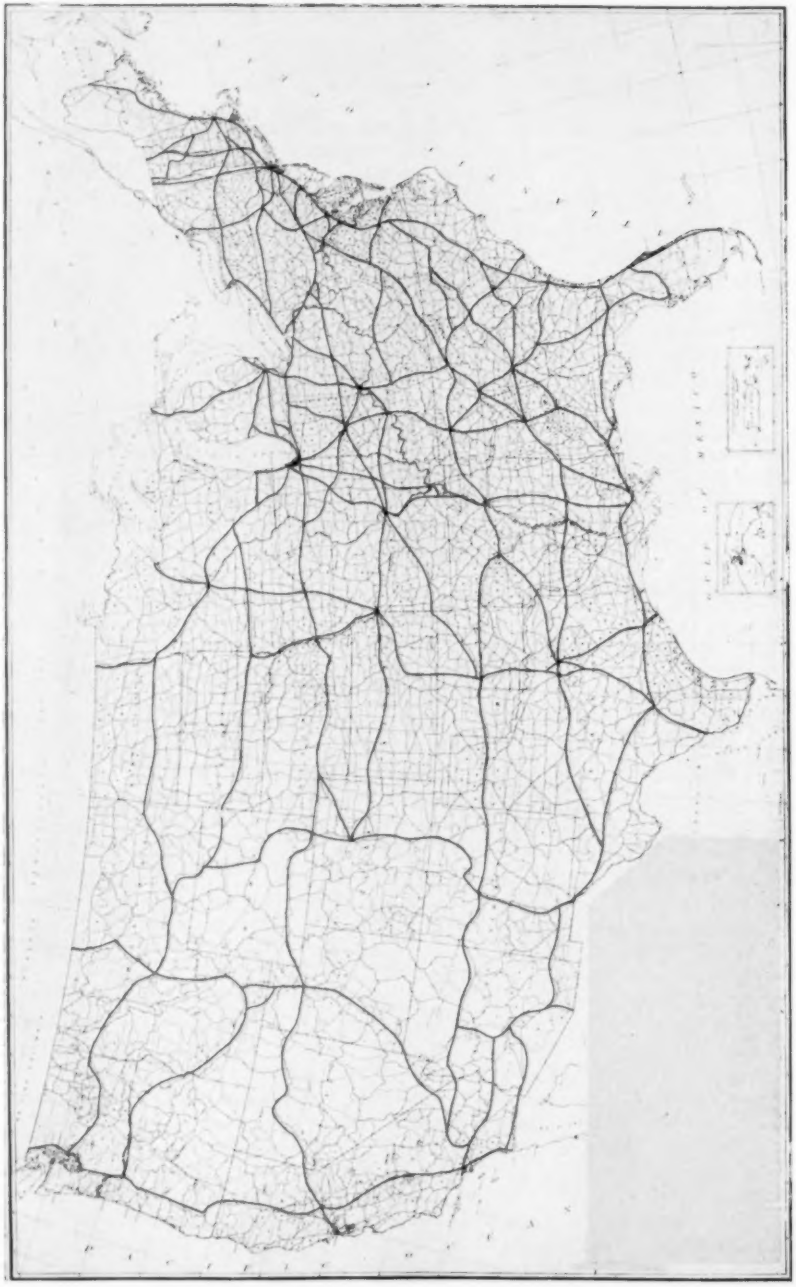


FIGURE 4.—Leveling net of United States with superimposed National System of Interstate Highways.

various commercial and industrial concerns and individuals. At present, the demands for control surveys are about three times as great as what we can accomplish with the appropriations available to us. This means that priorities must be established, with the most important control projects coming first.

The Coast and Geodetic Survey receives a large number of requests from State highway departments for data concerning our triangulation stations. If we are notified of the need for control in areas where it is now lacking, we will endeavor, within the limitations of funds and priorities established, to extend the surveys to these areas. We are not always aware where highway developments are planned, so that we cannot schedule our survey program to take care of the proposed work.

The Bureau of Public Roads and State highway officials should notify the Federal mapping organizations of their programs well in advance of their actual need for the surveys and maps. Many of the areas in which we establish control are of interest to more than one organization. For those areas on the Interstate Highway System where control is not available, it is likely that the highway needs can be correlated with demands from other organizations and incorporated in our program.

The fundamental control established by the Federal government should be used not only for the control of the mapping but also by the highway engineers in the planning stages and during the design and construction phases of the highway development. The Coast and Geodetic Survey determines the plane coordinate positions of the monuments for the triangulation control. In using such monuments, the highway engineer plumbs his instrument over the mark, obtains his initial azimuth from either an azimuth mark or an adjacent station in the Federal network and extends his traverse along the route of his survey. If possible, the survey should terminate with a position and azimuth connection to another station of the Federal network. This gives an immediate check on the accuracy of the field work.

Past experience has convinced us that, as the ease and facility with which the Plane Coordinate System can be used becomes generally known to the engineer and surveyor, such control will be used more often, and better and more efficient survey practices will result. Experiences of progressive highway engineers in such states as Massachusetts, Connecticut, California, and Maryland indicate that improved practices in connection with highway surveys result in increased efficiency and economy. The standards for highway surveys adopted by the Technical Division on Control Surveys of this Congress should be studied and evaluated by highway engineers concerned with surveying. The recommendations made therein should be adopted in highway survey practice. Such adoption will result in placing the survey program for the highways on a firm foundation, and the benefits accruing will be available in all phases of highway construction and improvement.

## Military Aspects

*By* COL. JOHN G. LADD
COMMANDING OFFICER, ARMY MAP SERVICE

ROADS are equally important to the progress, general welfare, and defense of our country. Many of the important events in our military history have centered around roads, and battles have been won or lost, depending upon the existence or the lack of them.

In colonial days mountain passes dictated the routes of the roads across the mountains and through the valleys. For

example, the military leaders of the colonial period discovered and made use of one of these old Indian routes. This route, which became known as the Cumberland Road (sometimes called the National Pike) was originally surveyed by George Washington. Half a century later it served as the spearhead into the Northwest Territory and accelerated the expansion of our country. This exemplified the importance of roads in military operations, since our troops could be quickly moved to the frontier to halt Indian uprisings.

Following colonial days, the War of 1812 indicated the urgent need for roads. The difficulties of moving troops revealed the insufficiency of existing means of transportation. Not only throughout our own history but from the time of the first armies of Rome, roads have been of vital interest to military commands. This makes adequate topographic mapping along these routes a necessity. Since military operations usually follow the principal routes of communication, adequate knowledge of the terrain on either side of the road is a prerequisite for adequate offensive and defensive operations. It is the responsibility of our armed forces to defend these routes and, to do so, accurate topographic maps are an absolute requirement. To cite a brief example, during the winter of 1950 elements of the First Marine Division fought their way out of the Changjin Reservoir area to Hungnam. The road they followed was almost impassable and at one point the bridge across a deeply incised river had been destroyed and no bypass was possible. No material for constructing a temporary bridge was available and the river gorge was too deep to permit the use of pontoon equipment. This almost impossible situation was solved smoothly and expediently. Eight spans of a 16-ton treadway bridge were flown to the area by eight "flying boxcars" of the 314th Combat Cargo Wing and dropped by parachute to the stranded Marines. This action was made possible by the use of accurate topographic maps whereby the Air Force determined the exact spot at which to drop the equipment so that it would not fall into enemy hands, that it would land in such terrain that the equipment would not be damaged, and that it would be in close proximity to the bridge site.

Should a campaign occur in our country, our highway system would be one of the primary targets. Because maps give a complete and accurate picture of the terrain they are invaluable to our military commands in determining what points would be vulnerable to enemy attack. With the knowledge of topography gained through the use of maps, defense plans could more readily be made for the deployment and movement of troops, positioning of artillery, maintenance of supply lines, and selection of strategic areas at which to stockpile material and equipment that would be immediately available for the reconstruction of any of the vulnerable points affected.

An intimate knowledge of terrain is a strong asset in any military operation. This was proved during the Revolutionary War when the ragged troops of George Washington, due to their knowledge of the countryside, successfully defended our country against vastly superior British forces. Maps are necessary in the selection of sites at which the enemy could be interdicted and in planning the best routes around any position under enemy control.

Most of our vital defense plants are situated near and dependent upon the principal routes of communication. The responsibility of defending these plants and maintaining these routes is becoming increasingly greater due to the fact that the plants are "decentralizing." They are producing at scattered points separate parts of the finished product and bringing them together for final assembly. If one of these plants were bombed by hostile aircraft, only a part of a "decentralized" plant would be destroyed. Our defense industry activities depend on our highway system for access to sources of

supply and distribution of finished products. In addition to troop and equipment transportation, the routes of communication must be kept open for these defense industries. Wartime loads are heavier than those during peacetime, partly because of the relaxing of restrictions on sizes and weights in order to permit the maximum possible utilization of our trucking capacity. With the possible temporary disruption of railroad service due to enemy action, we would have to rely even more on the capacity of our trucking industry. The result is to increase greatly the frequency of heavy gross loads, thus increasing the strain on pavements and bridges. These conditions would multiply the maintenance problems of the Corps of Engineers.

The Army Map Service has used map substitutes such as photo mosaics to some extent. However, it has been found through experience that the topographic map affords the only accurate portrayal of a part of the earth's surface.

A photo mosaic does not depict relief and, because it is inadequately controlled, it is impossible to make reliable horizontal measurements. Cultural features are often obscured or indistinct, and vegetation can very easily be misinterpreted. None of these deficiencies is found in a topographic map. The terrain can be more easily appreciated since this type of map is multicolored, and the symbol legend provides a key to its contents. Personnel need not be highly trained in order to read and understand it.

During 1950 and 1951 the Corps of Engineers is contributing funds to the U. S. Geological Survey for mapping strategic areas in the United States. Some of these areas fall within the quadrangle mapping for the Interstate Highway System, thereby aiding in this mapping program.

## Developing the Mapping Program

*By* ROBERT H. LYDDAN

CHIEF, PLANS AND COORDINATION BRANCH, TOPOGRAPHIC DIVISION, U. S. GEOLOGICAL SURVEY

BEFORE COMMENTING on the topographic mapping program that lies ahead, as visualized by the Geological Survey, and the coordination of that program with the map needs for highway development along the Interstate System, I would like to take just a few words to review the history of topographic mapping in this country.

First were the early maps of some of the coastal areas that were of particular interest to the explorers and settlers of Colonial America. Next were the maps that were made for military purposes during the American Revolution. During the following century some sketch maps were made in the West by explorers and by the Army in connection with the Indian wars. Following the Civil War the movement to "open up the West" gave rise to several mapping expeditions, and in 1879 the Geological Survey was formed to consolidate those efforts and make a more systematic attack on the mapping problem. During the 70 years since that time, the attack has been systematic enough but its scope, in terms of work completed, has been woefully inadequate. As most of you already know, general-purpose topographic maps that can be considered adequate for today's needs are available for only about one-fourth of the United States.

In contrast with the practice in equally advanced countries in Europe, topographic maps have never been extensively used here in the United States. Considering that few areas of any extent in this country are covered with maps of the same scale or the same vintage, if, indeed, they are covered with maps at all, it is not surprising that many engineers have failed to become greatly interested in using topographic maps or devising

methods for using them. As the mapping program progresses, however, and reasonably extensive areas become covered with maps of uniform scale and quality characteristics, I think it is safe to predict that map use will increase in geometric proportion to map availability.

Another contrast between this country and many of the advanced nations in Europe has to do with the comparative abundance of natural resources that we have enjoyed. With that abundance it has not usually been necessary to be frugal in the use of our natural resources. In that connection I would like to quote from House Document No. 706, page 20:

> The United States was born in the midst of a seemingly boundless wealth of natural resources. This very superabundance of nature's gifts stimulated both rapid and wasteful growth of the Nation, with little thought given to caution or frugality. During the past few years, however, this Nation has virtually been reborn into surroundings entirely unlike those of a decade or more ago—the economy is under constantly tightening restraints, many resources and raw materials are in short supply and virtually none are overabundant in relation to foreseeable needs, and international tensions are aggravated. As a nation, we need all possible tools and facilities to meet this challenge by vigorous and timely development, coupled with thoughtful conservation.

At this meeting, we are directing our attention to the highway engineer and the use that he might make of topographic maps. House Document 706 does not emphasize that aspect of map use. In fact, House Document 706 is directed primarily toward natural resources development. I think that that document does, however, give significant indication of the attention that is going to be given, in the foreseeable future, to topographic mapping as an adjunct to resources development and conservation.

Another positive requirement that is already accelerating the rate of topographic mapping in this country is the military requirement. In fact, defense requirements in the United States and Alaska are by far the greatest factors now guiding the Geological Survey in scheduling its mapping activities.

In the light of these two factors—military defense and natural resources development—both putting pressure behind the mapping program, we might look at our present rate of progress. More than 70 years of continuous effort have brought us up only to the quarter mark of the over-all job. At the same rate, another 200 years would be required to finish the job. Today, however, the production of standard topographic mapping in quadrangle form is progressing at such a rate that we can foresee getting the job done in about 40 or 50 years.

Now, to get back to the highway engineers, I might say somewhat facetiously that those of us in the Topographic Division of the Geological Survey only make the maps—it is up to someone else to figure out how to use them. More seriously, I would say that it appears that a lot of mapping is going to be done in this country in the foreseeable future—for defense purposes, for resources development, and for other reasons—and I would make this suggestion to the highway engineers: That they take a good look at topographic maps and determine what uses they might serve in highway work; and if it appears that they can be of considerable use, then the highway engineers should make themselves heard as to the kind of topographic maps they want—the scale, the content, the accuracy standards, and the areas that should be mapped first.

In some States, highway engineers have long been familiar with the topographic maps made by the Geological Survey. In Connecticut, Michigan, and several other States, we now have cooperative mapping programs directly involving the highway departments. In Illinois and Missouri, 10 or 20 years ago, we made strip maps covering areas within which new highways were expected to be developed.

Mr. Carpenter has already quoted from the statements that Mr. Hooper made earlier this year, describing how the Connecti-

cut Highway Department begins the study of highway problems by using the 1:31,680 scale, 10-foot contour quadrangle maps which are available in that State. In an article on the location of the Pennsylvania Turnpike, that appeared in *Engineering News-Record* in 1948, the writer describes the success they had in making and using a large-scale topographic map covering a strip about 1 mile wide along the general route that the highway was expected to follow. A very significant point in that article was the brief statement that a general route was selected by carefully studying the quadrangle maps before undertaking the large-scale topographic survey of the narrow strip enclosing the potential highway. The moral is, I believe, that if good quadrangle maps are available, then the very important first step can be readily taken in determining, within very narrow limits, the most feasible location for the new road.

It is obvious that highway engineers in some parts of the country are already making use of the topographic maps. The point we are trying to make here, I believe, is that there are many other areas where highway development will be facilitated if good topographic maps can be made available.

Before I finish I want to say something on the programming of mapping in the Geological Survey. At the present time, we are directing our principal effort into areas which the Defense Department has defined as being critical from a military standpoint. Mapping is also being scheduled in relation to other defense problems such as those connected with mineral exploration and water-power development. Although our efforts are now largely directed along these lines, we have not lost sight of the many other requirements for topographic maps. In fact, several months ago we undertook to work out a scheme by which we could rather systematically analyze map needs on an area basis, and also work out a reasonable discrimination between the two principal scales (1:62,500 and 1:24,000) at which the Geological Survey publishes topographic maps. That study is by no means complete—in fact, it will undoubtedly always require re-examination and re-evaluation as the evidence on map needs continues to accumulate. Briefly, however, it does take into account the relative map needs in the metropolitan areas, along the principal rivers and streams, in known or potential mineral areas, covering land suitable for irrigation, and along the principal transportation routes.

I'll end my comments on that last note, "along the principal transportation routes." I believe Mr. Carpenter has a very sound suggestion in proposing that thought be given to developing a mapping program along the System of Interstate Highways.

## The Highway Engineer's Viewpoint

*By* H. F. CLEMMER[2]

ENGINEER OF MATERIALS, DISTRICT OF COLUMBIA, REPRESENTING THE AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS

THE American Association of State Highway Officials is organized to foster the development, operation, and maintenance of a nation-wide integrated system of highways to serve adequately the transportation needs of our country. The officials of State, Territorial, and the District of Columbia Highway Departments and the Federal Bureau of Public Roads cooperate to develop and improve methods of design and to work with other agencies in the consideration and solution of highway problems.

The necessity for good maps has long been recognized as one of the requirements for development of satisfactory and economical highway locations. In 1919, Thomas H. MacDonald, Chief of the U. S.

[2] The paper was read by John E. Wiley.

Bureau of Public Roads, at a meeting of the Association in Louisville, Ky., said:

> . . . all the map-making agencies of the Federal Government were recently called into conference by the Secretary of War and the Chief of Engineers of the Army, and certain general policies were formulated to correlate the work of the several agencies and hasten the completion of the Geological Survey sheets.
>
> Their recommendations looking to the completion of these sheets are now before the President. The principles upon which the report is based are: first, that the Coast and Geodetic Survey shall be held responsible for the primary control lines; second, the Geological Survey shall complete the topographical sheets in accordance with their present standards; third, that all other map-making agencies of the government shall do their work in such a way that the information required to fill in the standard topographical sheets of the Geological Survey will be secured and will conform to the controls established.[3]

The Proceedings of the American Association of State Highway Officials for the 32 years since their Louisville meeting make few references to the use of maps in highway location. Locations have been generally developed along routes which had been pioneered by the settlers, oftentimes paralleling the railways.

It may seem that, with the major routes of the country substantially improved, as they are now, there should be no problem of location. This is not the complete picture for we have just started on a new phase of highway development. The paving on many of the old routes has been widened to about the limit of its economical use, without destroying valuable improved property along the right-of-way. Short-range studies of relocations to relieve intolerable conditions sometimes result in locations that are not correctly placed to provide a satisfactory final location for the entire route.

Expressway types of construction range in cost from half a million dollars a mile to several millions per mile. These expensive highways should not be located without the aid of map information of the best type. Poor location will mean not only high first cost but continuing waste of operating funds. Modern topographic maps covering a zone of sufficient width to cover all possible alternates would certainly be most desirable in the selection of locations for highways of this class.

The highway planning organizations of the State Highway Departments have accumulated information on road conditions through their periodic inventories of public roads. They know the true condition of all the important routes and can determine the priorities for construction programs for several years. Many States have made special long-time studies, known as "highway needs" reports, which set forth the deficiencies in the highway systems and schedule necessary construction projects to bring the highways to a condition adequate to serve the estimated traffic satisfactorily for a period of years.

When a section of highway between two important control points needs improvement, the natural tendency is to attempt to follow close to the present route, especially if there are no adequate topographic maps available. It has been said that the only permanent part of a highway is the location, and this is true if the location is made where it will continue to serve the area economically. During the development of our country, the location of railway rights-of-way were controlled by the maximum ruling grade. Without adequate topographic maps the expert railroad location engineers were forced to rely upon their sense of direction, judgment of topography, and arduous field investigations. Some of our highways were located in this same manner. Now, however, there are many features that must be given very careful consideration in developing the best location for a modern high-type highway, which did not exist in the early periods of railway and highway construction. Accurate topo-

[3] Discussion of a paper: *Maps of State Highway Systems for the Use of the Public.* Public Roads, Vol. 2, Nos. 21–22, January–February, 1920.

graphic maps prepared with adequate geodetic control and using modern methods of delineation of the topography will provide the necessary information to insure the correct location for routes that need replacement due to inadequacy of existing roads.

Within recent years the photogrammetric method of mapping has been developed and has been used by highway engineers for reconnaissance and detailed planning where good maps at the required scale were not available. The development of modern topographic maps at a scale of 1:24,000 will provide adequate information for a large part of the highway location problems we may expect to encounter in the next 30 years. The aerial photographs from which these maps are compiled may be used for detailed planning, and advance work sheets will be available for studies of topographic features. Photography obtained by highway engineers for locations of special projects usually has no permanent value after the line is finally selected. It seems that good topographic maps will provide a saving in cost of photogrammetric work that may be necessary for highway location.

As a representative of the American Association of State Highway Officials, I have no authority to commit the Association on policies to be adopted in considering the proposed project of mapping along the National System of Interstate Highways. Nevertheless, I am here to represent the Association at the request of the President, Gen. James A. Anderson of Virginia, and that in itself testifies to the interest of the official highway group in this project.[4]

[4] In a letter to Mr. Clemmer dated May 24, 1951, General Anderson said:

"I heartily approve of all you say in your paper on mapping and I am grateful for your help.

"We Highway Officials feel that our progress is handicapped without the benefit of up-to-date, accurate maps.

"For example, in Virginia all public roads in 97 of our 100 counties are under the State Highway Commission and have been since 1932. This gives us a 9,000-mile primary and a 39,000-mile secondary system, total 48,000 miles.

"Using base maps prepared by air photography we bring our county maps up to date each year. Only by this means can we measure progress, plan our program and improvements. Accurate maps are needed for the highway systems of any jurisdiction—town, township, county, state, nation. Maps are the best tools of highway engineers and administrators."

## Knows All Angles

A simple device that shows all the angles—on photographs—has passed operational tests at Fort Belvoir's Engineer Research and Development Laboratories. It is the photoangulator, which accurately gives true horizontal directions from oblique photographs. One type of military aerial photography which is used in the production of most aeronautical charts and in small-scale mapping and which is a prime source of reliable intelligence, is made with three cameras that simultaneously expose one vertical and two oblique photographs, thus covering a wide area. With the aid of the photoangulator, a network of intermediate horizontal control to which the map can be compiled is established from the oblique photographs.

There are three principal parts to the photoangulator: a depression-angle assembly for adjustment to the depression angle of the aerial camera at the instant of exposure; a transparent photo arm under which intermediate control points are intersected on the photo; and a templet arm that juts over the map manuscript and gives the true horizontal directions. A specially designed plastic slide-rule calculator enables the operator to obtain quickly the correct photo-arm setting.

The new device is considerably lighter and more compact than equipment now in use. The entire outfit can be securely carried in a weatherproof, hardwood case with dimensions

of 25½ by 8½ by 3½ inches, and a total weight, for instrument and case, of 14½ pounds.

Horizontal directions may be produced from 6-inch focal-length photography having camera tilts ranging from 40 to 72 degrees. The equipment can be satisfactorily used with a minimum of operator training. It is not affected by wide temperature changes and the materials are normally resistant to tropical conditions.

The basic instrument was invented by James G. Lewis of the U. S. Geological Survey, and the original model was built in June 1942. It was modified after extensive tests over a 5-year period. Project engineers incorporated an improved locking assembly, secured positioning pins with spring clamps, provided a longer noncorrosive templet arm, designed a means of determining the correct photo-arm setting, and redesigned the depression-angle adjustment mechanism. The instrument was standardized for issue to Engineer topographic troops.

The photoangulator differs from the present Corps of Engineers angulator and the Air Force rectoblique plotter, both of which present a geometrical solution in determining the horizontal direction of points on the oblique photographs, in that the photoangulator affords a trigonometrical solution.

* * *

## Fulbright Act Awards

THE Conference Board of Associated Research Councils has announced a competition for university lecturing and post-doctoral-level research in Europe and the Near East for the years 1953–54. Included are awards for Austria, Belgium and Luxembourg, Denmark, Egypt, France, Greece, Iraq, Italy, Netherlands, Norway, Turkey, the United Kingdom and its colonial dependencies; and also for Japan, Pakistan, and the Union of South Africa. Applications for this competition must be postmarked no later than October 15, 1952. Graduate students desiring to enroll for courses abroad or to pursue a directed program of studies at the pre-doctoral level should apply to their local Fulbright Adviser, or to the Institute of International Education in New York City.

# Surveying With the Magnetic Compass

*By* S. E. HUEY
ENGINEER AND SURVEYOR

MANY of the public lands of the United States were surveyed with the open-sight surveyor's compass mounted on a Jacob's staff. Also many private surveys of land were made with this instrument. Some few surveyors used a light tripod which gave a fairly firm support for this instrument.

When we consider that many of the surveys of public lands were let by contract to men who were not professional surveyors and that the measurement of distance was roughly done with the Gunter's chain made of links, through forests and across prairies of little value, we may agree that the accuracy of the work was generally consistent with the purpose of the survey. A resurvey between corners of these original surveys will usually show that the compass observations were as accurate as the measurement of distance.

The open-sight surveyor's compass is not in general use at the present time although a smaller type is still used in forestry work. The engineer's transit is equipped with a magnetic compass but the compass is seldom used by engineers and many surveyors use it only roughly for approximate directions.

As the original land surveys were made with the compass and were of low accuracy, and because many contemporary surveys made with the magnetic compass are also of low accuracy, the use of the magnetic compass has fallen into disrepute and its proper use has almost become a lost art.

The textbooks and handbooks on surveying give a description of the compass, its declination, and the variations due to diurnal and secular causes; then mention is made of the variations caused by local attraction and magnetic storms. All of which apparently thoroughly discourages anyone from proceeding further with the subject. Catalogs published by the manufacturers of the popular transits in general use in the United States give scant information regarding the magnetic compass with which the transit is equipped.

Our office occasionally rents instruments but very seldom do we obtain an instrument on which the compass is in working condition. I would hazard a guess that 90 percent of the transits in use today have a blunt or damaged pivot, or center, and are partly demagnetized from abuse.

The transit should be made with a compass box that provides easy access to the needle in order to shift the counterbalance to compensate for dip, and the center-pin should be easily accessible for replacement when damaged. It hardly seems necessary to mention that the bearing for the compass needle should be jeweled, however some 25 years ago I bought two light mountain transits, made by one of the best instrument makers, and the needle bearings were of Babbitt or some similar metal. One of the best compass needles that we have found is made of cobalt-tungsten steel; however, the manufacturer makes no mention of this in his catalog.

Assuming that the surveyor has one of the five or ten transits in a hundred that is equipped with a needle and pivot in good condition, the following procedure is used by our office:

A magnetic station can be established by observation of Polaris or one established by the Coast and Geodetic Survey may be used. Knowing the geographic position of this station, plot its position accurately on a Civil Aeronautics Administration (C. A. A.) chart and determine the declination to the nearest minute at this point. This is called the chart declination at the magnetic station. (For our station at Monroe, La. this chart declina-

tion is taken as 7° 13′ East.)

The transit is set up over the magnetic station. The transitman should carefully remove all objects containing iron or nickel from his person and never replace them while using the compass. A wrist watch should not be worn but, since a watch is needed in correcting for diurnal variation of the declination, a pocket watch may be carried and kept always in the same pocket. Keep all other metal surveying equipment 25 to 50 feet away from the transit.

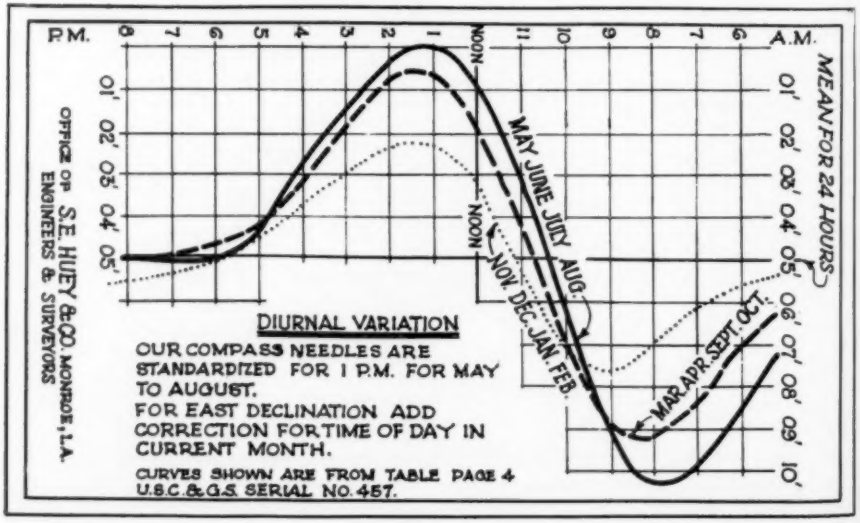
Stand on the south side of the transit facing north and, after leveling the transit, remove the cover of the compass box and balance the needle so that its south end is flush with the graduated compass circle. Set the compass declination vernier at zero and never use it again. Replace the cover of the compass box and allow the needle to settle.

Set the "A" vernier of the horizontal circle at zero. Then, using a reading glass, set the south end of the compass needle on the south zero of the compass circle, using the lower tangent screw and being careful to keep the eye lined up with the axis of the needle to avoid parallax. Always use the same eye. Loosen the upper clamp and point the telescope on true north, reading the angle of declination on the "A" vernier. Note this angle, the date, and time of day. Now loosen all clamps on the instrument, revolve once or twice on its vertical axis and repeat the procedure for another reading. About 10 readings should be taken to get a good average and to gain confidence in the needle.

The following is the record of 10 readings taken at the magnetic station in Monroe, La. on November 15, 1951, by an office engineer who had not been in the field for about a year:

| | | |
|---|---|---|
| 1:15 p. m. | 7° 32′ | |
| | 7° 28′ | |
| | 7° 31′ | |
| | 7° 29′ | |
| | 7° 30′ | Average = 7° 30.5′ |
| | 7° 31′ | say 7° 31′ |
| | 7° 31′ | |
| | 7° 31′ | |
| | 7° 31′ | |
| 1:30 p. m. | 7° 31′ | |

From the chart of diurnal variation (*see* accompanying figure), it is noted that for 1:30 p. m. in November the east


P.M.
A.M.
NOON
NOON
MAY JUNE JULY AUG.
NOV. DEC. JAN. FEB.
MAR. APR. SEPT. OCT.
MEAN FOR 24 HOURS
DIURNAL VARIATION
OUR COMPASS NEEDLES ARE STANDARDIZED FOR 1 P.M. FOR MAY TO AUGUST.
FOR EAST DECLINATION ADD CORRECTION FOR TIME OF DAY IN CURRENT MONTH.
CURVES SHOWN ARE FROM TABLE PAGE 4 U.S.C.&G.S. SERIAL NO. 457.
OFFICE OF S.E. HUEY & CO. MONROE, LA. ENGINEERS & SURVEYORS

declination is 0° 02′ more than the minimum east declination which occurs about 1:00 p. m. on the May to August curve. Therefore, the minimum east declination for this particular transit is 7° 29′ East at Monroe. Also this compass needle points 0° 16′ to the right or East of the chart declination since the chart declination is 7° 13′ East.

Each compass needle has its own particular declination which may vary in modern transits by 15 minutes or more. We recently standardized the needle in an old transit which reads 5° 29′ East at Monroe. This transit gives good results on compass surveys. There is also some difference between the readings of different instrumentmen and it is best to have each instrumentman standardize his own instrument. This difference is due to the zero coincidence setting used by each individual on the south end of the needle.

Before proceeding to the location where a compass survey is to be made the surveyor should procure a general map of the area on some convenient scale such as 1 inch to 1 mile and on this map carefully plot the magnetic declination lines for each 5-minute change in declination as scaled from the C. A. A. charts. The declination to the nearest minute can then be scaled or estimated in the field. For the ordinary land survey the chart declination will be constant throughout the survey, but for a route survey a correction for position is made at 1-minute intervals, as shown on the map referred to above.

As an example of procedure, we will assume that the surveyor travels to a point in Lincoln Parish some 40 miles northwest of the magnetic station at Monroe, La. From this point it is proposed to run a route survey in a westwardly direction for 10 to 20 miles.

The preliminary location of the route survey has been plotted on the general map referred to and the point of beginning is found to have a declination of 7° 31′ East. Thus the chart declination at the point of beginning is 7° 31′ East or 0° 18′ more east declination than at Monroe where the chart declination is 7° 13′ East.

If the survey is begun at 8:00 o'clock on a November morning with the transit having a minimum east declination at Monroe of 7° 29′ then the minimum east declination for station 0+00 is 7° 29′ plus 0° 18′ or 7° 47′. Add the correction for diurnal variation of the declination from the figure, which is 0° 07′, giving a total declination of 7° 54′ East. The surveyor sets off this declination of 7° 54′ East on the limb or horizontal circle using the "A" vernier as follows:

With needle lowered and the "A" vernier set roughly on zero, point the telescope approximately to true north, loosen the upper clamp and point the telescope east of north, setting the "A" vernier on 7° 54′. Next loosen the lower clamp and point the telescope closely to magnetic north, observing the south end of the needle; tighten the lower clamp and bring the south zero of the compass circle into coincidence with the south end of the compass needle using the lower tangent screw. This setting is carefully made, using a reading glass. The horizontal circle is now oriented on true north and true bearings or azimuths can be observed by pointing the telescope and reading the "A" vernier.

On each succeeding set-up of the transit on the route survey the time of day is noted and the diurnal correction is added to the minimum declination for position (7° 47′ East). As the survey proceeds westwardly the declination for position is changed at intervals as determined from the isogonic lines drawn on the general map. In this particular case an increase of 0° 01′ in east declination would occur at intervals of approximately 2 miles.

The surveyor has now applied about all the practical corrections that can be made to the declination of the compass needle and its variations. I might mention here that the secular or annual change can be taken into account by standardiz-

ing the compass needle semiannually or annually as required and by using the latest C. A. A. charts.

At each set-up it is customary to plunge the telescope and observe the line back, to see that no gross error has been made. No rear rodman is required and line clearing can be done with machetes. Trees larger than 3 inches in diameter are seldom cut, and points beyond larger trees can be carefully set by leaning and then plumbing a range pole or even by carefully observing the head chainman's elbows or outstretched hands. Offsets to parallel lines are easily made to avoid large trees. Errors in setting points on line are compensating, rather than propagating as for double-center transit work.

It is not intended to suggest that the compass is an instrument of precision even when used as outlined here. However, with reasonably accurate chaining and careful use of the transit's compass, surveys with a closure of 1/3,000 can be made, which is a precision sufficient for most land surveys and better than necessary for practically all location or route surveys. A requirement of second- or third-order precision in route surveys or preliminary surveys is expensive. Such precision is much easier to obtain on the "take-up" or final survey, after all clearing for construction has been done and grades are then usually much more suitable for accurate chaining. Route survey specifications often require a double-center tack line with Polaris observations at regular intervals checking the traverse bearings to a specified number of minutes, with no mention or allowance made either for convergence of the meridians or the degree of accuracy required in chaining. Also consider the fact that, in computing the closure of a traverse having deflection angles of say 5°, these angles should be measured with an error of less than 5 seconds for third-order closure.

Returning to the compass, it will be found that its use is particularly suited for all forms of stadia surveys, for the accuracy of the compass will exceed that of all stadia measurement excepting the 1 to 5,000 precision claimed for the tripod mounted horizontal Invar rod used with optical transits or theodolites.

Local attraction due to objects of iron or steel, iron ore, direct current wires, or machinery will deflect the compass needle, and the surveyor will find it necessary to abandon the use of the compass needle and use the usual form of transit traverse in such locations. Magnetic storms are comparatively rare and are evidenced by erratic action of the compass needle. The use of the compass is abandoned during these periods and the work continued with transit traverse.

The diurnal variation of the declination as shown by the curves in the figure are the averages for a series of years, but on any particular normal day the departure from the daily mean may be 50 percent greater than the values given by the curves. It has been our practice to disregard these departures with satisfactory results.

Surveying handbooks and textbooks outline many of the advantages of the compass survey and should be consulted. Gurley's Manual of Surveying Instruments is also a good reference. The following is quoted from Henry Wild Surveying Instruments Supply Company's booklet describing their compass-theodolite:

> In measuring long traverses, the compass-theodolite, as is well known, has a decided advantage over the ordinary theodolite for two main reasons. On one hand, the law of error-propagation for a compass-traverse is much more favourable than for an ordinary traverse. Thus, over long distances, despite the lesser accuracy of a single angle-reading, the total of the compass-traverse readings shows a greater accuracy than the total of readings taken by an ordinary theodolite.
>
> This may be clearly shown by the following comparison between two sets of readings, one made by an ordinary traverse, and the other by means of a compass-traverse. Supposing that a theodolite-reading has an error of ±20″, a compass-reading an error of ±1′ or ±2′, the following table results, according to Jordan's formulae of error propagation:

| Length of trav. Each side 100 m long | Mean closing error of | | |
|---|---|---|---|
| | Ordinary Traverse $m_a = \pm 20''$ | Compass Traverse | |
| | | $m_a = \pm 1'$ | $m_a = \pm 2'$ |
| 500 m | ± 0.07 m | ± 0.07 m | ± 0.13 m |
| 1,000 m | 0.18 | 0.09 | 0.19 |
| 2,000 m | 0.52 | 0.13 | 0.26 |
| 5,000 m | 2.00 | 0.21 | 0.41 |
| 10,000 m | 5.63 | 0.29 | 0.58 |

Aside from this very favourable error-propagation, the use of the compass-theodolite posseses a further substantial advantage over the ordinary theodolite in that every other station of the latter is eliminated. When using an ordinary theodolite, one is obliged to set up the instrument on every traverse point, which calls for particular care in centering. In contrast to this, the compass-theodolite is set up on every second point only, since the compass aligns itself automatically with the magnetic pole. In a compass-traverse the time-wasting centering of the instrumuent is eliminated, the number of stations reduced by half, and the marking of each staff and instrument station is unnecessary.

The use of the magnetic compass is indicated for surveys of limited precision, such as many preliminary surveys, most rural land surveys, control surveys which are to be plotted at intermediate scale, stadia and many topographic surveys, and particularly location or route surveys.

In uncleared or wooded areas where precision approaching third-order accuracy is required it is often advisable to make preliminary compass surveys and follow up with a precise survey after the area or right-of-way has been cleared.

# Architects, Engineers, and Surveyors Practice Overlaps

## (*Opinion of the South Carolina Attorney General's Office*)

THE national headquarters of the National Council of State Boards of Engineering Examiners is located at Columbia, South Carolina. Inquiries are often received at this office regarding the procedures followed in the various States when the practices of architects, engineers, and land surveyors overlap or infringe on one another. In this connection there was published in the 1951 annual report of the South Carolina State Board of Engineering Examiners an opinion rendered by the South Carolina Attorney General's office which is reprinted here for the benefit of our members:

In our opinion the 1948 Act provides for two different categories, one for professional engineers and the other for land surveyors. Just because a man may be a professional engineer he is not necessarily equipped to do land surveying. An engineer may be fully qualified to build bridges, skyscrapers, mechanical equipment, and many other things without even having taken plane surveying. On the other hand many professional engineers are fully qualified to survey lands and make plats of the surveys. A surveyor is not necessarily, however, an engineer or civil engineer.

"Doubtless civil engineers must at times be surveyors but it in no wise follows that a surveyor must be a civil engineer." *Evans* v. *State* (Alabama), 146, So. 287.

Section 7076 as shown in the 1948 Act reads as follows:

"Examinations shall be given for the purpose of determining the qualifications of applicants for registration separately in engineering and in land surveying."

This alone shows that the Legislature recognized that an engineer was not necessarily qualified to survey land.

In our opinion if one holding an engineering certificate makes plans and specifications, plats, and performs other work that land surveyors ordinarily do, this would not require a license by the engineer as a land surveyor if such work was done in furtherance of a legitimate engineering project or was a part thereof; if, however, the engineer held himself out and advertised his services to survey land, make plats and do other work generally done by land surveyors and such work was not in connection with the building of structures and the carrying on of the practice of engineering as defined in the Act then the engineer would have to obtain a license as a land surveyor; not otherwise.

A statute very similar to ours was construed by the Supreme Court of Utah in 1942 (*Smith* v. *American Packing and Provision Company,* 130 Pa. (2d) 951). In this case a California professional engineer came into Utah, made up plans and specifications and supervised the construction of a large packing plant. When the job was finished he tried to collect but payment was refused on the ground that he had no license as an architect. The Court held that as the main part of his work was engineering work for which he was duly licensed, the mere fact that some of his work overlapped into the field of architecture did not require him to have an architect's certificate. Everything he did worked toward the carrying out of the engineering project.

The test as stated by the Court was as follows:

"The real criterion for determining if a licensed professional engineer must also have a license as an architect, is not whether some service he performs might be performed lawfully by an architect, but whether such functions are necessarily embraced within the scope of engineering covered by his license: The issuance of a license in one field is not to be employed as a stepping stone to practice in some other field or even in a part of such other field unless the functions of such other field performed by the licensee are necessarily embraced within the scope of the activities authorized by the license."

In conclusion, one qualified as an engineer cannot survey land, make plats and perform the duties of a land surveyor unless in connection with some engineering project on which he is engaged, without obtaining a certificate and license as a land surveyor. If in the regular line of engineering, plans, plats and surveys have to be made the engineer can make these and does not have to have a land surveyor's license to do so. If the engineer advertises and takes over land surveying duties unconnected with his regular professional engineering duties, he must have a land surveyor's certificate, as well as his engineer's certificate.

* * *

## New Mississippi River Map Folio

THE Mississippi River Commission has prepared a new folio of hydrographic-topographic maps of the Mississippi River from Vicksburg, Miss., to Red River Landing, La., based on hydrographic surveys of 1948–51 and aerial photographs taken in 1948–49. The folio is 14½ by 22 inches in size and contains an index map, scale 1:500,000, with notes and legend.

There are 49 hydrographic-topographic sheets, scale 1:20,000 or about 3¼ inches to a mile, showing river soundings. Elevations in feet are referred to mean sea level, and geodetic positions are referred to Mississippi River Commission datum. Five-foot contours above and below low-water plane are shown.

The 14 aerial mosaic sheets are at a scale of 1:40,000 and were prepared from an aerial survey of 1948–49. Information is similar to that on the hydrographic-topographic sheets, except that no river soundings or contours are shown.

The 67-sheet folio, printed by black-line photo-offset reproduction may be purchased at a cost of $1.50 from the Mississippi River Commission, Corps of Engineers, Department of the Army, P. O. Box 80, Vicksburg, Miss. Remittance should be made payable to the Treasurer of the United States.

# Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

## CURRENT SURVEYING AND MAPPING LITERATURE

### MAGAZINE ARTICLES

THE SCOPE AND PATTERN OF GEOGRAPHY. Sir Harry Lindsay, President, Royal Geographical Society. *The Journal of the Manchester Geographical Society*, Vol. LV, 1949–50. (". . . survey of the Scope and Pattern of Geography by a check-up based on the objectives which the study of Geography is best calculated to serve.")

RECENT DEVELOPMENTS IN HYDROGRAPHIC SURVEYING AND CHARTING. Rear Admiral Robert F. A. Studds, Director, U. S. Coast and Geodetic Survey. *The International Hydrographic Review*, Vol. XXVIII, No. 2, November 1951. (Discusses progress by the Coast and Geodetic Survey in the use of electronic equipment in hydrographic surveying and in the design of its nautical charts.)

A WORD FROM AMERICA. Extracts from a letter received by Mr. R. G. Dick, Surveyor General of New Zealand, from Mr. S. A. Bauer, Past President of the American Congress on Surveying and Mapping. *New Zealand Surveyor*, Vol. XX, No. 7, December 1951. (Praises talk made by Mr. Dick at the 11th Annual Meeting and expresses admiration for the British Commonwealth surveyors.)

THE ACTIVITIES OF THE GEODETIC TRIANGULATION AND MAPPING PARTIES AT REPOROA. R. P. Gough. *New Zealand Surveyor*, Vol. XX, No. 7, December 1951. (Interesting detailed account of the procedures and methods employed by the New Zealand Lands and Survey Department on an extensive project of surveying and topographic mapping.)

PERMAFROST. Louis L. Ray, U. S. Geological Survey. *Arctic*, Vol. 4, No. 3, December 1951. Paper presented at Permafrost Symposium, first Alaskan Science Conference, November 11, 1950, Washington, D. C. (General discussion of permafrost, definitions of terms used in its study, and of the complexities and difficulties man has encountered in adapting himself to his conditions.)

THIRTY YEARS OF MAPPING IN NORTHERN CANADA. M. J. L. Rannie. *Annuaire de la Corporation des Arpenteurs-Geometres de la Province de Quebec*. 1951. (Address before the 68th General Assembly of the Corporation at Quebec, April 18–19, 1951.)

INSTRUMENT APPROACH AND LANDING CHARTS. T. Freer. *The Journal of the Institute of Navigation*, Vol. V, No. 1, January 1952. (Discusses the actual needs of the pilot and suggests a simplified form of the approach and landing chart.)

LEVEL OF ENGINEERING EDUCATION MUST BE RAISED. Excerpts from report of Committee on Adequacy and Standards of Engineering Education of the Engineers' Council for Professional Development. *Civil Engineering*, Vol. 22, No. 1, January 1952. (Stresses need for giving students a greater knowledge of basic sciences and increased capacity for self-development and creative thinking.)

MAP MOUNTING PROCEDURE. Fritz Kramer. *The Journal of Geography*, Vol. LI, No. 1, January 1952. (Simple, step-by-step directions and list of materials needed, for mounting maps on cloth with rollers.)

NEW JERSEY TURNPIKE—TOMORROW'S HIGHWAY BUILT TODAY. Symposium. *Civil Engineering*, Vol. 22, No. 1, January 1952. (A symposium consisting of 13 topics by different authors providing the complete story of the planning and construction of the recently opened 118-mile superhighway.)

OUR HOME-TOWN PLANET, EARTH. F. Barrows Colton, *The National Geographic Magazine*, Vol. 101, No. 1, January 1952. (Popular discussion of the forces of nature which have been and are shaping the earth.)

RECENT MAPS OF INTEREST TO TEACHERS OF GEOGRAPHY. Marie Cleckner Goodman, Library of Congress. *The Journal of Geography*, Vol. LI, No 1, January 1952. (A selected group of maps, both government and privately published, domestic and foreign, described from the viewpoint of the teacher of geography.)

SOLVING THE RIDDLE OF CHUBB CRATER. V. Ben Meen. *The National Geographic Magazine*, Vol. 101, No. 1, January 1952. (Describes work of the expedition to the site of an unusual crater in Ungava, Northern Quebec, and the collection of evidence on the basis of magnetometer surveys that it is of meteoric origin.)

SOME RECENT WORK ON POLAR NAVIGA-

TION. Lt. Comdr. L. R. R. Foster, R. N. *The Journal of the Institute of Navigation*, Vol. V, No. 1, January 1952. (Describes voyage which involved navigating in ice in both the Antarctic and Arctic. Discusses ship construction tion and techniques of navigation in polar areas.)

THE CANADA LANDS SURVEYS ACT. B. W. Waugh. *The Canadian Surveyor*, Vol. X, No. 11, January 1952. (Summarizes the act and discusses changes as they affect status of Canadian surveyors.)

THE MARKING OF SURVEY STAKES WITH RADIO-ACTIVITY. W. R. Dixon and L. H. Greenberg. *The Canadian Surveyor*, Vol. X, No. 11, January 1952. (Puts forth possibility of adding relatively inexpensive radioactive material to survey markers to facilitate their speedy recovery by Geiger counters or similar instruments.)

MAPPING OUT OF CROWN LANDS IN CEYLON. G. B. King, Surveyor-General, Ceylon. *Empire Survey Review*, No. 83, Vol. IX, January 1952. Concluded in No. 84, April 1952. (Discusses surveying methods employed in solving complex and difficult problems of land apportionment. Includes interesting descriptive and historical material on the island of Ceylon.)

PORT OF BOSTON GETS A FACE-LIFTING. George L. Wey, Chief Engineer, Port of Boston Authority. *Engineering News-Record*, Vol. 148, No. 8, Feb. 21, 1952. (Describes current development of new waterfront terminals and other improvements. Illustrated by aerial photos.)

THE AMERICAS SIT FOR THEIR PORTRAIT. W. J. Banks and Bart McDowell. *The Rotarian*, Vol. LXXX, No. 2, February 1952. (Popular discussion of the program for mapping the Western Hemisphere, including the activities of the Inter-American Geodetic Survey.)

PRECISION LEVELING AT THE WHITE HOUSE. Howard S. Rappleye. *Transactions American Geophysical Union*, Vol. 33, No. 1, February 1952. (The Chief of the Section of Leveling of the U. S. Coast and Geodetic Survey gives an illustrated account of the meticulous survey, during reconstruction of the White House, to ascertain the stability of the foundation and walls of that historic building.)

BARGAINING BY PROFESSIONALS. Editorial. *Engineering News-Record*, Vol. 148, No. 11, March 13, 1952. (Predicts future increase in collective bargaining by engineers and suggests need for the profession to take a more rational and less emotional approach to collective bargaining just as it changed its attitude toward licensing of engineers 20 years ago.)

ELECTRONIC DEPTH RECORDER DETERMINES STATE BOUNDARY. *Engineering News-Record*, Vol. 148, No. 11, March 13, 1952. (Describes river bottom survey using a Bendix DR-8A Depth Recorder to determine a part of the state boundary between Illinois and Kentucky.)

THE AMERICAN GEOGRAPHICAL SOCIETY: 1852–1952. John K. Wright. *The Scientific Monthly*, Vol. LXXIV, No. 3, March 1952. (Brief account of the founding and subsequent history of the Society with some emphasis on the changes in policy due both to leadership and changing world conditions.)

THE CALIFORNIA-NEVADA BOUNDARY. Benjamin E. Thomas, University of California, Los Angeles. *Annals of the Association of American Geographers*, Vol. XLII, No. 1, March 1952. ("The history of the line . . . illustrates the principles that accurate location of state boundaries—as well as international borders—is both difficult and necessary; that indefinite frontiers, under our system of laws, can easily lead to serious disputes; that rivers are zones instead of lines and therefore are often objectionable as reference points for boundaries; and that boundaries arbitrarily prescribed for distant unknown regions have often been perplexing ones for both the inhabitants and the surveyors.")

MOUND BUILDERS OF THE MISSISSIPPI. James A. Ford. *Scientific American*, Vol. 186, No. 3, March 1952. (Includes an account of surveying and mapping techniques as applied to archeological exploration.)

THE MULTIPLEX, KELSH PLOTTER, AND WILD AUTOGRAPHS. Luis Struck. *Photogrammetric Engineering*, Vol. XVIII, No. 1, March 1952. (Discusses the relative merits of the three instruments on the basis of long experience.)

OUR SHRINKING GLOBE. Kenneth K. Landes. *Bulletin of the Geological Society of America*, Vol. 63, No. 3, March 1952. (A scholarly discussion of the Earth's isostatic balance and the factors which contribute to its change.)

PHOTOGRAMMETRIC GEODESY AND GEODETIC PHOTOGRAMMETRY. W. O. Byrd. *Photogrammetric Engineering*, Vol. XVIII, No. 1, March 1952. (Points out the hitherto unconsidered relationship between the two sciences, photogrammetry and geodesy.)

SCIENCE IS NOT ENOUGH. J. K. Finch. *Journal of the Franklin Institute*, Vol. 253, No. 3, March 1952. (". . . As we have attempted to show in this outline, engineering is still a practical art, reinforced and strengthened, to be sure, by science stemming from both pure and engineering sources, but its major objectives are still economic and social in their nature rather than scientific, while its practice involves many elements, such as industrial and business economics, human relations and the planning and direction of labor, which

requires interests and abilities having little relationship to scientific teachings and for which the study of science alone does not offer an adequate preparation.'')

THE USE OF AERIAL PHOTOGRAPHS IN A TROPICAL COUNTRY (SURINAM). A symposium by 5 authors. *Photogrammetric Engineering*, Vol. XVIII, No. 1, March 1952. (Subtitles are: I. General—Jan I. S. Zonneveld; II. Topographic Maps—Jan I. S. Zonneveld and Bernard J. Beltman; III. Geological Reconnaissance—Jan I. S. Zonneveld and Albert Cohen; IV. Forest Photo-Interpretation in Surinam—Dammes Heinsdijk; V. Soil Mapping from Aerial Photographs—Jacob J. v. d. Eijk; VI. Conclusion—Jan I. S. Zonneveld. Bibliography.)

THE PACIFIC FLOOR. Robert S. Dietz, U. S. Naval Electronics Laboratory, San Diego, Calif. *Scientific American*, Vol. 186, No. 4, April 1952. (Takes reader on an imaginary submarine trip along the west coast of the United States, Alaska, and Aleutians, and the Hawaiian Islands, describing the undersea topography as it has been revealed by electronic surveying methods.)

UNCONTROLLED MAPPING FROM AIR PHOTOGRAPHS. R. W. Pring. *Empire Survey Review*, Vol. XI, No. 84, April 1952. (Describes practical methods for tracing from unmounted photo mosaics to produce maps for special purposes, or in cases where any kind of a map is regarded as better than no map at all, thus using available photo coverage until more accurate maps can be compiled by photogrammetric process.)

EFFECT OF WIND-GENERATED WAVES ON MIGRATION OF THE YUKON RIVER IN THE YUKON FLATS, ALASKA. John R. Williams, U. S. Geological Survey. *Science*, Vol. 115, No. 2993, May 9, 1952. (Presents observations leading to the conclusion that waves generated in summer by strong upriver winds are an effective erosion agent on the north bank of the river and accelerate the northward migration of the river.)

UNIONISM OR PROFESSIONALISM? A. J. Ryan. *The Engineers' Bulletin*, (Colorado Society of Engineers), Vol. 36, No. 5, May 1952. (Another opinion in the current controversy over the status of the engineering group; this one recommends a serious striving for the attainment of a professional level comparable with medical and legal professions rather than a resort to union organization.)

THEY EXPLORE OUR UNKNOWN COAST. William L. Worden, *Saturday Evening Post*, Vol. 224, No. 50, June 14, 1952. (Describes the work of the Coast and Geodetic Survey on desolate Barter Island in the Arctic, the last unsurveyed mainland coast under United States jurisdiction.)

## BOOKS AND PAMPHLETS

SOIL SURVEY MANUAL. Soil Survey Staff, Bureau of Plant Industry, Soils, and Agricultural Engineering, Department of Agriculture, Washington, D. C. August 1951. 503 pages, illustrations. $3.00. (Intended for use by soil scientists engaged in soil classification and mapping. Attention is directed primarily to problems and methods of making and interpreting detailed basic soil surveys in the United States and territories.)

GEOGRAPHY IN THE MAKING — THE AMERICAN GEOGRAPHICAL SOCIETY: 1851–1951. John Kirtland Wright. *The American Geographical Society*, New York. 1952. 437 pages, illustrations. (Deals with the history of the Society, its guiding policies, constitution, publications, awards, and the revision of its program to accord with the spirit and needs of the times.)

THE EFFECTS OF ENGINEERING ON WESTERN CIVILIZATION. James Kip Finch, Columbia University School of Engineering. 397 pages. *McGraw-Hill Book Co.*, New York and London.

—LYMAN D. LYNN

## DISTINCTIVE RECENT MAPS

*Canada: Principal Mining Areas and Producing Mines.* Canada, Dept. of Mines and Technical Surveys, Mines Branch, and Geological Survey of Canada. 1952. Colored. 31 by 37 inches. 1: 7,603,200. Contrasting colors show the following geographical regions: Canadian Shield; Greenstone areas within the Canadian Shield; Interior Plains, St. Lawrence, Hudson Bay, and Arctic Lowlands; Appalachian Region; Cordilleran Region; and Intrusive rocks within the Cordilleran Region. Symbols show metallic and non-metallic mineral properties, oil and gas fields, and coal properties. Mining camps are named and oil pipe lines are indicated. Seven insets locate specific minerals. Graphs show values of mineral production (1939–1950). A marginal Index to Principal Productive Mines, 1950, (with names of operating companies) contains valuable information.

*Davey Jones' Locker* (Cape Cod). Everett R. Graichen, Treasure Trow, Providence, R. I. 1952. Colored. 17 by 21 inches. 1: 180,000. A picturesque map which children will love. ''Popular imagination regards Cape Cod as one of the most likely spots for pirate gold.'' The

names of 455 of the 3,500 cargo ships wrecked in the shallow waters surrounding the Cape are recorded on the map, together with the dates of their sinking. The names of famous pirates decorate the border.

*Part of Old Philadelphia, a Map Showing Historic Buildings and Sites.* Compiled by Grant Miles Simon; published by the American Philosophical Society. Philadelphia. 1952. Colored. 26 by 24 inches. 1: 2,350. Existing historical buildings, sites of historical buildings, and existing buildings of the early 19th Century are depicted. This map is based on a portion of the first city plan in the colonies (Philadelphia) by Thomas Holme, 1683. There are so many notes on this new map that it has a slightly congested appearance.

*Progress in Soil Conservation Works Completed in Soil Conservation Districts.* (U. S.) U. S. Soil Conservation Service, Beltsville, Md. Jan. 1952. Colored. 13 by 21 inches. 1: 9,000,000. Under the heading "Districts Organized to July 1, 1951" are shown by contrasting colors: New districts and those up to 10 percent completed, districts 10 to 25 percent completed, districts 25 to 50 percent completed, and districts 50 percent or more completed. The territories appear in insets. "Conservation work completed to July 1, 1951, equals 21.4 percent of all land in farms for nation."

*Triadelphia Reservoir Watershed Drainage Map.* U. S. Soil Conservation Service. October 1951. 18 by 22 inches. 1: 50,000. The area depicted includes Frederick, Howard, and Montgomery Counties, Md. A blue overprint (showing drainage) on a reduced aerial mosaic.

*Minor Tributary of the Triadelphia Reservoir Watershed; Frederick, Howard and Montgomery Counties, Maryland.* U. S. Soil Conservation Service, Beltsville, Md. Feb. 1952. Colored overprint on aerial mosaic. Three maps, each 22 by 17 inches. 1: 8,200.

1. "Streambank and Highway Erosion and Areas Having Water Problems." Intensity of erosion is shown by contrasting colored lines at side of streams. Roadside erosion is indicated by symbols.
2. "Land Capability and Present Land Use." Shows by contrasting colors three classes of land according to use capability at the time of mapping: Land unsuited or not well suited to cultivation which was cultivated or idle, land well suited to cultivation which was in pasture or woodland, and land fairly well suited to cultivation which was cultivated or idle.
3. "Physical Land Conditions" shows by contrasting colors six classes of land according to use capability.

*Kansas Mineral Resources.* State Geological Survey, University of Kansas. 1951. Colored. 32 by 45 inches. 1: 600,000. Shows mineral industries, oil and gas, oil shale, ceramics, cement, clay and shale, Portland cement, hydraulic cement, volcanic ash, rock wool, stone, chalk, sand and gravel, salt, gypsum, zinc and lead, chat, coal, and industrial minerals. The extensive legend describes the resources and gives production values for many products.

*Map Showing Indian Reservations in the United States.* U. S. Indian Service, Washington 25, D. C. Blue and black. 14 by 19 inches. 1: 9,500,000. Shows reservations and tribal lands and agency headquarters. Rancherias and Indian reservations too small to show to scale are indicated by small squares. On verso: (1) Map showing probable location of Indian tribes north of Mexico about A. D. 1500, (2) Culture areas and approximate location of American Indian tribes today, and (3) List of U. S. Indian Service publications.

*Map of Potteries.* Published by the Pottery Gazette and Glass Trade Review, Scott Greenwood & Son, Ltd., 8 Ludgate Broadway, London EC 4, and printed by the Surrey Fine Art Press, Ltd., Redhill, Surrey. 1952. Colored. 27 by 9 inches. A strip map which shows the potteries in Tunstall, Longport, Burslem, Cobridge, Hanley, and Etruria. The verso locates the china companies in Newcastle, Stoke-on-Trent, Fenton, Longton, Barlaston, and Stourbridge. The names of the firms in the margins are keyed to the map. An additional alphabetical list indexes the potteries. Bus routes and important public buildings are also shown.

*Autokaart van Nederland.* Published by Koninklijke Nederlandsche Toeristenbond A.N.W.B. 1951. Colored. 3 overlapping sheets which when put together would measure about 55 by 55 inches. 1: 200,000. A very detailed map showing several classes of roads, railroads, waterways, and general cultural information.

*Autokaart met alle verharde wergen Nederland,* Falk Plan. N. V. Cartografisch Instituut Bootsma, The Hague. Colored. 1: 250,000. The patented folding and distance indicators system makes this map unique. "The Falk-Plan can be looked in by turning over the pages as in a book, whereas the side-parts can be pulled out or turned over to the left or to the right. For a general view of the whole map it can be entirely unfolded." When folded into the cover, this atlas measures 11¼ by 5¼ inches. Numerous insets show the major cities and towns of the Netherlands. An extensive index plus a list of auto dealers makes this a valuable map for the tourist.

*Kaart van het Ijsselmeer.* Published by Born's Uitgeverij N. V. Assen. 1951. Colored. 33 by 24 inches. 1: 125,000. A very detailed

sea chart with 8 enlarged insets. Gives depths, lights, and buoys.

*Waterkaart Zuid-West Friesland.* Published by Bureau voor Watertoerisme and the Kon. Ned. Toeristenbond A.N.W.B. 1951. Colored. 24 by 36 inches. 1: 50,000. A detailed map showing a unique waterways pattern.

*Religions—und Missionkarte der Erde.* 1951. Evang. Missionsverlag G. m. b. H., Stuttgart-S. Herstellung: Richard Schwarz KG. Frankfort a/M 1. Colored. 32 by 43 inches. 1: 40,000,000. By contrasting colors shows 11 religious bodies. Graphs show by percentages religious affiliations of the populations.

*Eisenbahnen in der Bundesrepublik Deutschland.* Herausgegben von der Hauptverwaltung der Deutschen Bundesbahn in Offenbach, Georg Westermann Verlag in Braunschweig. 1951. Colored. 52 by 38 inches. 1: 750,000. Shows various municipal headquarters and administrative divisions of the German railroad bureau. Several classes of roads and railroads in use and under construction are indicated. Internal and external boundaries are sketched. An inset is titled "Rheinisch-Westfälisches Industriegebiet."

*Malarial Areas in the Union of South Africa.* Malarial Survey by the Dept. of Public Health of the Union—1938. Reprinted by the Government Printer, Pretoria, 1951. Colored. 41 by 34 inches. 1: 1,000,000. (T.S.O. Misc./826.) In English and Afrikaans. Under four classes of malarial areas are shown corresponding risks and prevalence. Internal boundaries, roads, railways, mission stations, and post offices are indicated.

*The Cape Peninsula.* Drawn by Plik or Paulick (a free-lance cartographer in Cape Town). Published by the Cape Peninsula Publicity Assn., Cape Town, South Africa. 1949. Colored. 20 by 13 inches. 1: 120,000. Shows roads, railways, built-up areas, and fishing spots. Relief is shown by modified hachures.

*A Map of the Cape Peninsula* issued by the Cape Peninsula Publicity Assn., Adderley Street, Cape Town, South Africa. 1951. Colored. 24 by 15 inches. 1: 100,000. A colorful pictorial map. On verso: photographs and a brief history of the settlement of the Cape.

*Southwest Asia; India, Pakistan, and Northeast Africa.* National Geographic Society. June 1952. Colored. 27 by 38 inches. 1: 7,500,000. Shows political divisions by contrasting colors and relief by plastic shading. Features stressed are principal railways, roads, and airports, oil pipe lines, oil fields, canals, water holes, volcanic debris, areas below sea level, and dry salt lakes. An inset of the same area, "The Moslem World," indicates the percentage of Moslems in the total population. Geographical equivalents and abbreviations are listed in the margin.

*Iran Road Map.* U. S. Army Map Service, (AMS K201). First edition. Feb. 1952. Colored. 33 by 34 inches. 1: 2,500,000. Polyconic projection. Shows classes of roads and railroads, boundaries, spot elevations in feet. Relief is shown by modified shading. An inset gives an "Index to Boundaries in Iran." A short glossary of English and native generic terms appears on the map.

*Pahang 1951.* Published by Survey Dept., Federation of Malaya. Colored. 4 sheets each 25 by 22 inches. 1: 253,440. Modified Polyconic Projection. Shows roads, railroads, internal boundaries, bench marks, trigonometrical stations with height in feet, special reserves for forests, game, mining, and agriculture, and many other details.

—WALTER W. RISTOW
—MARIE C. GOODMAN

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# Catskill Region Map

ONE of the newer members of the ACSM, Rudolf R. von Siegl, of Rhinebeck, N. Y., has recently published an interesting map of the Catskill Region in New York. This map was designed specifically for the tourist who has time to stop and see points of interest or to make side trips, or who plans to vacation in the area.

The map is in 9 colors including a brown shaded-relief overprint. It measures 29 by 29 inches and is at the scale of about 1: 160,000. In addition to the usual map features, such tourist attractions as ski slopes, camp sites, park areas, fire towers, and historic buildings and monuments are shown. As an unusual feature, the map indicates the species of game fish to be found in each stocked stream.

The map is priced at $1.50, and can be obtained by writing to Rudolf R. von Siegl, Stoneerest, Rhinebeck, N. Y.

# Books in Review

GEOLOGIC GUIDEBOOK OF THE SAN FRANCISCO BAY COUNTIES (Bulletin 154, Division of Mines, State of California). Prepared under the direction of Olaf P. Jenkins, Chief, Division of Mines, San Francisco, Calif. 1951. 392 pages. $2.50.

Let the potential reader be not misled by the title of this bulletin. It is true that it does treat of geology but if that were all, I should not have attempted to review it. The subtitle of the bulletin more clearly shows its scope: *History, Landscape, Geology, Fossils, Minerals, Industry, and Routes to Travel.*

The book is fascinating. It treats of 12 counties, 9 of which border on the shores of San Francisco Bay, the other 3 being in the delta region of the San Joaquin and Sacramento Rivers. Both the casual reader and the student will find much of interest in the 32 authoritative articles that comprise the book, each article prepared by an expert in the specific subject. But all the articles are written in an easily understood manner and the text is supplemented with nearly 300 illustrations. And most of the articles append a bibliography, useful to those whose interest is incited to further reading and research.

The bulletin starts with an historical background of the area and includes articles on place names, the Indians, early adobe houses, etc., and follows with a section on the "History of the Landscape," a part of which should be of particular interest to our members.

Part three deals with the geologic history of the area, including an article on earthquakes; followed by part four about prehistoric life, the animals, fossils, and prehistoric forests; followed by part five dealing with mineral industry and part six dealing with surface water supplies.

The last part is entitled "Places to Go and Routes to Travel" and for those who like to study geology by automobile it is an invaluable collection of motorlogs for short trips on which many of the noteworthy formations may be seen.

This complete story of the landscape not only tells the background against which the human history of the San Francisco Bay area occurred, but also shows the natural reasons for the course of that history.

K. T. ADAMS

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PHOTOGRAMMETRIE. Dr. Richard Finsterwalder. *Walter de Gruyter & Co.*, Berlin. 1952. 377 pages. DM 32. German text.

This comprehensive textbook is a revision of Prof. Richard Finsterwalder's first edition published in 1938. The pedagogical value of the book can be attributed to the author's long experience as a professor of photogrammetry at the Technical University in Munich. Its worth as a textbook is further enhanced by a practical viewpoint which reflects years of practice in the field.

In the historical introduction, the author chronicles the development of the science from early terrestrial applications to modern aerial techniques. Named in the chronology are the men whose works contributed to the advancement of photogrammetry. That genius of old, Leonardo da Vinci, properly leads the list. Rudiments of the subject follow the brief historical treatment. Presented in logical order are sections dealing with the photographic objective, photography, geometric principles including the epipolar theory, stereoscopic vision and measurement, and the geometry of the photograph. The last section covers the comparator measurement of photocoordinates and the analysis necessary to determine the inner orientation of a terrestrial photograph.

The sound treatment of terrestrial photogrammetry is based on the author's extensive field experience which has included the leadership of several expeditions to the Himalayas for purposes of topographic mapping and glaciological studies. He has ably carried on in the tradition established by his father, S. Finsterwalder, who pioneered in this field. As the basic field instrument, the phototheodolite is described with respect to its characteristics, testing, and adjustment. The terrestrial photograph is analyzed from the standpoint of its use as the basis for triangulation and

graphic techniques. Complete utilization of terrestrial photographs by the stereophotogrammetric process is introduced with the development of the parallax theory covering all cases of orientation. The effect of phototheodolite calibration errors on parallax measurements is also considered. The oldest stereoplotting instrument, the Orel-Zeiss Stereoautograph, is shown to be an effective means of plotting from the stereopairs produced by the phototheodolite. In conclusion, the author emphasizes the value of terrestrial photogrammetry for mapping mountainous terrain which might otherwise be impossible by aerial methods.

The principal chapter of "Photogrammetrie" deals with aerial methods. A discussion of aerial photography and the survey camera introduces this section, which covers the following subjects: resection in space as applied both to the single exposure station and to the double point or stereoscopic problem; stereoscopic model deformation due to errors in the elements of orientation; stereoscopic plotting instruments; aerotriangulation as applied in stereoscopic and radial methods; stereophotogrammetric topographic mapping; and approximate and rapid methods of plotting.

Such an array of subjects indicates the scope of this chapter. Limitations of space allow only the presentation of the fundamentals. But the basic theory is here and when one has mastered it, he may proceed, as in the case of error theory, to the more advanced works of Hallert, Bachmann, and others. Stereoscopic model deformation as a function of differential changes in the elements of orientation will appeal to the mathematically inclined reader. For one whose interest centers on the practical aspect of topographic map plotting accuracy, there is a section which develops altimetric error as a function of the vertical and horizontal errors of stereoplotting. This approach should be refreshing to those who question that treatment of contour accuracy which disregards ground slope. The topographer's domain is also recognized in a discussion of the geomorphological accuracy of stereoscopically drawn contours. Finally, the economics of map production, at least from the German standpoint, will interest those engaged in planning and estimating.

An anticlimatic chapter on rectification gives the projective geometry approach to the theory of the anharmonic or cross ratio and to graphical techniques. A description of Zeiss rectifying instruments, no longer available, is accompanied by an outline of operational procedure. The accuracy and use of mosaics are covered in the concluding paragraphs.

Modern emphasis on photointerpretation is recognized in a chapter by W. Pillewizer. The discussion embraces interpretation as related to geography, geology, and forestry.

The significance and practical use of photogrammetry, as outlined by Prof. Finsterwalder in the concluding chapter, would receive wider appreciation if "Photogrammetrie" were published in English. Such publication would give the Enlish-speaking student the benefit of its value as a textbook and would guide the advanced reader to other works which appear in the many footnote references and in the bibliography.

ROBERT C. ALTENHOFEN
*U. S. Geological Survey*

## New Manual of Photogrammetry

THE Manual of Photogrammetry, published by the American Society of Photogrammetry, is expected to be available on or about August 15, 1952. It is described by the Society as a handbook by the leading experts in each phase of the subject. There will be 20 chapters and more than 800 pages. The Manual will be copiously illustrated. It is essentially a new handbook, rather than a revision of the Manual published in 1944.

The price to non-members of the American Society of Photogrammetry is $12.50; to members of the Society before publication it is $7.50, after which it will be $9.00.

# MAP INFORMATION

This department was inaugurated for the purpose of bringing to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession. —EDITOR

## Topographic Maps

THE FOLLOWING quadrangle maps, topographic or planimetric, were published between March 1 and May 31, 1952, by the U. S. Geological Survey (New Publications Lists 524 through 526). Planimetric maps (no contours) are indicated in the list by the letter (P) following the name. All maps are available with or without the green overprint which indicates woodland. The quadrangle name is shown in capital letters, followed by the county name in upper- and lower-case letters. Since many quadrangle maps extend into several counties, only that county name is given which contains the place for which the quadrangle is named. For example, the quadrangle HULACO, in *Alabama*, is in parts of Cullman, Marshall and Morgan counties, but only Morgan is shown because the town of Hulaco is in that county.

Maps of areas east of the Mississippi River may be ordered from the Chief of Distribution, U. S. Geological Survey, Washington 25, D. C., and of areas west of the Mississippi River from the Distribution Section, U. S. Geologcial Survey, Denver Federal Center, Denver, Colo.

*Alabama*

HULACO—Morgan

*Alaska*

ANCHORAGE (C-7)*—Third Judicial Division†
ANCHORAGE (C-8)*—Third Judicial Division†
ANCHORAGE (D-3)*—Third Judicial Division
ANCHORAGE (D-4)*—Third Judicial Division†
ANCHORAGE (D-5)*—Third Judicial Division†
ANCHORAGE (D-6)*—Third Judicial Division†
ANCHORAGE (D-7*)—Third Judicial Division†
ANCHORAGE (D-8)*—Third Judicial Division†
BIG DELTA (A-4)*—Fourth Judicial Division†
FAIRBANKS (A-4)*—Fourth Judicial Division†
FAIRBANKS (B-4)*—Fourth Judicial Division†
FAIRBANKS (C-5)*—Fourth Judicial Division†
FAIRBANKS (D-1)*—Fourth Judicial Division†
FAIRBANKS (D-2)*—Fourth Judicial Division†
FAIRBANKS (D-4)*—Fourth Judicial Division†
GULKANA (A-5)*—Third Judicial Division†
GULKANA (B-2)*—Third Judicial Division†
GULKANA (C-1)*—Third Judicial Division†
HEALY (A-4)*—Third Judicial Division
HEALY (A-5)*—Third Judicial Division†
HEALY (C-4)*—Fourth Judicial Division†
HEALY (D-2)*—Fourth Judicial Division†
HEALY (D-3)*—Fourth Judicial Division†
HEALY (D-4)*—Fourth Judicial Division†
HEALY (D-5)*—Fourth Judicial Division†
NABESNA (C-6)*—Third Judicial Division†
NABESNA (D-6)*—Third Judicial Division
TALKEETNA MOUNTAINS (B-4)*—Third Judicial Division†
TANACROSS (A-4)*—Fourth Judicial Division†
TANACROSS (B-5)*—Fourth Judicial Division†
VALDEZ (D-4)*—Third Judicial Division†
VALDEZ (D-8)*—Third Judicial Division†

*California*

INGLEWOOD—Los Angeles†
LA HABRA—Orange
MOUNT GODDARD*—Fresno
SCHELL MTN.—Shasta
SOUTH GATE*—Los Angeles†
THOUSAND OAKS—Ventura
WEAVERVILLE*—Trinity

*California-Arizona*

WHIPPLE MOUNTAINS*—San Bernardino

*Colorado*

GATEWAY—Mesa†

*Colorado-Wyoming*

KINGS CANYON—Larimer
NORTHGATE—Jackson

*Florida*

ARIEL—Volusia†
AURANTIA—Brevard
BAY KEYS—Monroe†
BOCA CHICA (P)—Monroe†
COTTRELL KEY—Monroe†
EDGEWATER—Volusia†
KEY WEST—Monroe†
MAYTOWN—Volusia†
SNIPE KEYS—Monroe†
SUGARLOAF KEY—Monroe†

*Georgia*

NEELS GAP—Lumpkin
SUCHES—Union

*Idaho*

FILER—Twin Falls

* Indicates 15-minute quadrangle; all others are 7½-minute quadrangles.
† Indicates map lies wholly within county named.
‡ Indicates availability in either a contour or a shaded-relief edition.

GOSHEN—Bingham
INDIAN COVE*—Owyhee
JEROME—Jerome
NIAGARA SPRINGS—Gooding
ROCHAT PEAK—Benewah
TWIN CRAGS—Kootenai

*Indiana*

PIERCETON—Kosciusko

*Indiana-Kentucky*

BEECHWOOD—Crawford
CHARLESTOWN—Clark

*Kansas*

DEWEY RANCH*—Rawlins
LAWRENCE EAST—Douglas
ST. FRANCIS 3*—Cheyenne
SCOTT CITY*—Scott

*Kentucky*

OLIVE HILL—Carter

*Louisiana*

DRY CREEK—Beauregard†
HAMMOCK LAKE—St. Mary
LAKE POINT (P)—Iberia
MOUND POINT—Iberia†
WEST OF JOHNSONS BAYOU—Cameron

*Maine*

ROBBINSTON—Washington†
WHITING—Washington†

*Maryland-Pennsylvania-West Virginia*

BELLEGROVE—Allegany

*Minnesota*

ST. CLOUD*—Benton

*Missouri*

CABOOL NW—Texas
CABOOL SW—Texas
CARROLLTON EAST—Carroll
COLOMA—Carroll
PLYMOUTH—Carroll

*Montana*

VAUGHN*—Cascade

*Nebraska*

ARABIA*—Cherry†
DORSEY—Holt
DORSEY NW—Holt†
LYNCH—Boyd
PISHELVILLE—Knox
VERDIGRE NE—Knox
WOOD LAKE*—Cherry

*Nebraska-South Dakota*

MONOWI—Boyd

*Nevada*

MT. ROSE*—Washoe†
VIRGINIA CITY*—Storey

*New Mexico*

READING MOUNTAIN—Grant†

*New York*

BURDETT—Schuyler†
CHURCHVILLE—Monroe
ITHACA WEST—Tompkins†
LE ROY—Genesee
MARATHON—Cortland

*North Carolina*

HAVELOCK—Craven
NEW BERN—Craven
ORIENTAL—Pamlico

*North Dakota*

BUCHANAN—Stutsman†

*Oregon*

BROWNSVILLE*—Linn
MARCOLA*—Lane

*Pennsylvania*

VALENCIA—Butler

*South Carolina*

CLEMSON—Pickens

*South Dakota*

CONATA SW—Shannon
EDGEMONT NE—Fall River
FAULKTON EAST—Faulk
FLINT HILL—Fall River†
IMLAY—Pennington
IMLAY SE—Shannon†
IMLAY SW—Shannon†
MINNEKAHTA—Fall River
WECOTA—Faulk

*South Dakota-Nebraska*

NIOBRARA—Nebraska†

*Tennessee*

JACKSON SOUTH—Madison†
MICHIE—McNairy
MURFREESBORO—Rutherford†
WOLF PIT RIDGE—Hardin†

*Tennessee-Alabama*

LOWRYVILLE—Hardin
PICKWICK—Hardin

*Texas*

LAKE COLORADO CITY—Mitchell
WESTBROOK—Mitchell†

*Utah*

ANTELOPE PEAK—Iron†
ENOCH NE—Iron†
GOSHEN VALLEY NORTH—Utah†
SOLDIERS PASS—Utah†
WEST MOUNTAIN—Utah†

*Virginia*

COBB ISLAND—Northampton†
FAIRFAX—Fairfax†

*Washington*

HAY*—Whitman
NESPELEM*—Okanogan

*Wisconsin*

BALSAM LAKE*—Polk†
ELCHO* (P)—Langlade
LILY* (P)—Langlade
TOMAHAWK* (P)—Lincoln†
TURTLE LAKE*—Barron

*Wyoming*

BISHOP—Natrona†
BONNEVILLE SW—Fremont†
CASSA—Platte†
FORT LARAMIE—Goshen†
LOST WELLS BUTTE—Fremont†
REGISTER CLIFF—Platte
RIVERTON NE—Fremont†

In addition to the standard series of quadrangle maps, reconnaissance maps at the scale of 1:250,000 are being published for both the continental United States and Alaska. Maps in this series published in the period include the following:

*Alaska*

AMBLER RIVER—Second Judicial Division†
AMUKTA—Third Judicial Division†
ARCTIC—Fourth Judicial Division†
BEAVER—Fourth Judicial Division†
BETTLES—Fourth Judicial Division†
BROOKS—Fourth Judicial Division
HUGHES—Fourth Judicial Division
KWIGUK—Second Judicial Division†
MISHEGUK MOUNTAIN—Second Judicial Division†
MOUNT McKINLEY‡—Fourth Judicial Division
ST. MATTHEW‡—Second Judicial Division†
SURVEY PASS—Second Judicial Division
UMIAT—Second Judicial Division
VALDEZ‡—Third Judicial Division†

*Arkansas and Mississippi*

HELENA

*Louisiana*

BRETON SOUND

*New York*

BUFFALO

*Pennsylvania*

HARRISBURG

## How Topographic Maps Are Made

A PAMPHLET entitled "How Topographic Maps Are Made" has just been issued by the Tennessee Valley Authority. This brief pamphlet has been prepared to be understood by children, and the steps in making a topographic map are illustrated by simplified cartoon-type line drawings. In the appendix are samples in color of the various cartographic phases of making a topographic map. The cover of the pamphlet is a part of an actual topographic map.

# Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR

## CIVIL ENGINEERING VERSUS LAND SURVEYING

FORREST DANIELL*—Many discussions have been published in SURVEYING AND MAPPING and elsewhere showing a healthy interest in the conflict between the civil engineer and the land surveyor. Milton O. Schmidt, an associate professor of civil engineering, University of Illinois, writes that it would be "fallacious to engage a civil engineer to make a property survey whose successful execution depended upon a thorough knowledge of land-line retracement procedures in a particular locality" (1). He likewise takes the position that the practicing land surveyor should not disclaim the possibility of a college-trained civil engineer being qualified to make an adequate land survey.

I have no doubt that a person who has the educational background of a civil engineer makes a better land surveyor than if he lacked that training. This does not necessarily mean that any civil engineer will make even a fair land surveyor, nor dies it imply that a person without college training cannot deserve a reputation as an expert on land surveying. I, personally, know a score of good land surveyors who have not had the benefit of a college education.

George C. Bestor, in a letter to S. A. Bauer some time ago, was indignant at the fact that the California State Board of Registration for Civil and Professional Engineers does not consider surveying a branch of engineering, and yet the Board grants permission to perform any service a licensed surveyor can do in California if he passes the civil engineering examination in which there is seldom a question on surveying and never a question on legal descriptions or property laws. Mr. Bauer replied that in Ohio a civil engineer may practice surveying without being registered as a surveyor, but the surveyor cannot practice engineering without being registered as an engineer (2).

Efforts in several States to prevent a civil engineer practicing as a land surveyor *until after qualifying* as such, have not been successful.

I agree with R. D. Comstock that a person must be both a civil engineer and an experienced land surveyor before he can properly evaluate the misunderstanding between the college-trained civil engineer and the surveying practitioner. Comstock says that he is one who believes that a college-trained civil engineer makes a poor land surveyor, but that he could be among the best if he were willing to assume the responsibilities that accompany the general practice of land surveying (3). Many civil engineers are also land surveyors with respectable reputations. However, the reason most civil engineers do not take to land surveying is because they cannot visualize any worthwhile accomplishment after the job is done. In engineering, a dam, highway, building, or bridge is a visual monument of the work of the engineer. The civil engineer as such—as Comstock says—does not possess "the state of mind" required in land surveying.

S. P. Chapman, in his article, "Training Surveyors for the Oil Industry," (4) says: "There is a certain amount of training that must be done right on the job. No schooling or technical training can entirely take the place of practical job training. Field engineers will always have the responsibility for most of the training. . . . We must all take our share of responsibility in training our own men." Others of us in the oil industry have found it necessary to expose our civil engineer graduate trainees to extensive abstracting of deed records and field experience as chainmen and instrumentmen before they can qualify as land surveyors.

* Registered Professional Engineer, Houston, Tex.

Prof. Milton O. Schmidt also writes that "There are few, if any, giants among the surveying teaching profession. . . . The surveying divisions of our civil engineering departments have not attracted their share of those graduate engineers who have leavened their fund of knowledge with the maturity that comes only from contact with a turbulent world" (5).

Leland Barclay, Professor of Civil Engineering, University of Texas, in addressing the Fourth Texas Surveyors' Short Course Conference in Austin on October 14–15, 1948, said that the college had failed to attain a high standard in its surveying instruction for only a little surveying was required for a degree in civil engineering. Mr. Barclay also stated that as these courses were given in the freshman and sophomore years, and as a large number of college students were forced to withdraw due to the lack of general scholastic ability or finances, it was a natural thing for them to become surveyors without further educational training and without trainee experience as land surveyors. Mr. Barclay struck a clear note when he suggested that if all courses in surveying required for a degree were given in the junior and senior years, we would advance toward making surveying a "learned profession."

I, too, agree with Charles R. Herr when he states that, in the curricula usually established to cover the field of engineering where a C.E. degree is the goal, surveying and mapping usually take a beating. Mr. Herr wrote that at the California Institute of Technology one had to go to class to learn Structures, Hydraulics, and many other construction subjects, but in surveying the students received some lectures plus a little field practice. This course of study was sometimes reinforced by a summer job on a survey party. This teacher of surveying pointed out that "This all adds up to a good engineering background but leaves the graduate lacking in surveying to the extent that in most cases he is a liability instead of an asset to his employer." Mr. Herr contends that "there is room in some schools for a degree in Surveying and Mapping—a course where the various fields of engineering are tied into surveying as they might have to be met in the field, on the job, or from a blueprint."

Prof. Phillip Kissam, of Princeton University, some years ago pointed out that the principle of land surveying represents one of the highest forms of civil engineering and that "The usefulness of the land surveyor's work depends not as much on precise surveying (which he must thoroughly understand) as upon his experience and knowledge of the methods and legal procedures connected with land surveying, a knowledge which takes years to acquire." He says that civil engineers frequently think of surveyors as a sort of apprentice civil engineer, an attitude probably wholly justified since a surveyor is by no means a *land surveyor*. Professor Kissam contends that not only does a civil engineer confuse the surveyor and the land surveyor, but frequently the general public, the legal profession, and the surveyor himself believes that because a man can make a survey, he can make a *land survey* (7). All this, of course, is contrary to the facts.

Wm. C. Wattles has found that many applicants taking written examinations do not have the fundamental knowledge required to undertake the general practice of land surveying (8). He thinks that the reason for failure in the written examinations of most of the applicants is the lack of training and experience of the proper quality, which is reflected back to the practitioners for whom the applicants have worked as subordinates. Mr. Wattles did not point out whether it was the civil engineer, the industrial surveyor, or the practicing land surveyor who more often failed these examinations, but he did point out that a qualifying written examination prevents a land surveyor practicing as such without a thorough working knowledge of basic surveying principles.

Usually, a land surveyor prefers to be known as a civil engineer rather than a land surveyor. I think Walter S. Dix struck the keynote when he pointed out that we should strive for a professional status through accomplishing the objectives of ACSM (9). We can then expect to be recognized by engineers in general and by the public at large. Mr. Dix notes that engineers graduate into professional status "with the firm conviction that surveying and mapping is 'leg-work,' to be done whenever possible by embryo engineers, students, sub-professionals, and possibly a few helpers" (10). If a civil engineer has not had specialized training as a land surveyor, he should be very careful not to encroach upon the field of land surveying.

"The vocation of the civil engineer has always been invested with a dignity of its

own" (11). A. C. Mulford explains that we give engineering adequate attention in our technical schools, but that we relegate surveying to the freshman class. He reminds us that the surveyor deals with one of the oldest and most fundamental facts of human society—the possession and inheritance of land.

In closing, it appears to me that, with the possible exception of a land surveyor practicing in a rural area, the ordinary land surveyor will find many of his clients demanding his services as a civil engineer, as well as a land surveyor. Then too—with the increasing use of the State Coordinate Systems, photogrammetry, control, and topographic surveying—we, as surveyors of all categories, must extend our horizons and embrace civil engineering as an inseparable part of land surveying.

## REFERENCES

(1) "College Training in Land Surveying," SURVEYING AND MAPPING, July–Sept. 1951, page 261.

(2) Comment and Discussion, SURVEYING AND MAPPING, Jan.–Mar. 1951, page 86.

(3) Comment and Discussion, SURVEYING AND MAPPING, Oct.–Dec. 1951, page 412.

(4) Presented at Second Texas Surveyors' Short Course, Dec. 5–6, 1941, Austin, Tex., (Report) page 49.

(5) Comment and Discussion, SURVEYING AND MAPPING, April–June 1951, page 179.

(6) "Surveying and Mapping in the Junior College," SURVEYING AND MAPPING, April 1945, page 47.

(7) Discussion in SURVEYING AND MAPPING, July 1943, page 11.

(8) "The Land Surveyor," SURVEYING AND MAPPING, July 1943, page 9.

(9) "A Reconnaissance," SURVEYING AND MAPPING, April 1944, page 2.

(10) Until recently the U. S. Census classified surveying as "and other semi-professional occupations."

(11) "Responsibilities of the Surveyor," SURVEYING AND MAPPING, July 1945, page 7.

## CORRECTION

FOWLER C. BARKER†—Thank you for doing such a fine job of editing the paper which appeared in the most recent issue of SURVEYING AND MAPPING, on the subject of "A Planned Program of Resource Surveys." However, I cannot take credit for any part of the article, except that I condensed the original version and read it for Ford Bartlett, president of the civil and photogrammetric engineering firm of Lockwood, Kessler & Bartlett, Inc. In the preliminary remarks I so stated, and gave credit to his firm's E. C. Squire and Aubrey DaSantos, for their help in its preparation. Naturally, it would be very impolite of me not to write you along these lines and suggest that you publish this letter if you have space, which I hope you do, in justice to the gentlemen who are responsible for the contribution for which you unintentionally gave me credit.

† Secretary, Association of Professional Photogrammetrists.

## FROM NEW MEMBERS

Have just received your quarterly Journal for January–March 1952.

To state that its contents were enthusiastically received would be putting it mildly. This organization is one which has been sorely needed in the profession for a long time.

I am writing you at this time to obtain the full publications of the Congress for 1950–1951 (Vols. X and XI). Would appreciate your effort in letting me know the cost of this, if available, and I will forward a check to cover the expense.

Only a few months ago I became a member of ACSM; these short months have convinced me that this organization is a most useful one and I can hardly wait for the time until the next issue of SURVEYING AND MAPPING arrives. This is a treasured and most inspiring publication, and I only wish it could be a monthly one.

# CONGRESS NEWS

## Secretary's Report

The business of the American Congress on Surveying and Mapping since the Eleventh Annual Meeting last June, to this Twelfth Annual Meeting, under President FitzGerald during 1951 and President Harding in 1952, was accomplished as usual by ACSM's volunteer staff officers and committeemen, the Technical Divisions, the Local Sections, and the support of a loyal membership—quietly, efficiently, and we hope effectively.

Official minutes record three Board of Direction Meetings, four Executive Committee Meetings, and one special Executive Meeting, guiding the actions of ACSM up to the time of this reporting. Various reports of chairmen and officers together with activities of the Twelfth Annual Meeting elsewhere in the pages of our Journal, will give you a far more interesting account of ACSM's activities than a lot of dry statistics from the Secretary. Let me briefly summarize the highlights then, as follows:

The Resolutions passed at the Eleventh Annual Meeting were widely distributed.

Committee work for the Twelfth Annual Meeting was started early.

Nominations committee work and balloting procedures were routinely accomplished. The Board approved placing an amendment before the membership for ratification in regard to raising yearly dues to meet expected rising operational costs.

Board approval and committee action culminated in contract arrangements for accepting advertising for publication in SURVEYING AND MAPPING.

Appointment of Robert C. Eller as Assistant Editor.

Activation of the Committee on Map Use, with Walter G. Stoneman its appointed chairman.

Activation of the Constitution Committee, under chairmanship of Vice President William T. Pryor.

Continued alertness to unprecedented actions of U. S. Civil Service Commission in matter of umbrella grouping of surveying and mapping classifications under a Cartographer Series, which actions were taken with no consideration of opinions of various professional and technical organizations concerned.

The national activity of ACSM is evidenced by growing activity of its Local Sections of which there are now three—Texas, Northern California, and Southern California; the increasing interest in Technical Divisons of ACSM; and the affiliated interest of organized or organizing groups of surveyors in various States of the Nation. Besides Georgia, Michigan, Virginia, and New York—already affiliated with ACSM—activity in Maryland, northern Virginia, Florida, North Carolina, Indiana, Illinois, and elsewhere indicate further affiliations.

WALTER S. DIX
*Executive Secretary*

## Editor's Report

The work of the Editor's office begins where the Publications Committee leaves off. The primary function is to give the manuscript material a final edit, to prepare the copy for the printer, to proofread all galley and page proof, to prepare the "make-up," and to take care of all "filler" items.

In the preparation of material for the printer, the Editor is constantly aware of the importance to the reader of a well-presented and well-designed article. Such matters as type-size and style, form of presentation, spacing, indentions, and size of illustrations and their distribution, receive meticulous attention. We are constantly on the alert for improvements that will add to the reader interest yet without detracting from the dignified character of our Journal.

Two changes have been effected in the Journal format that it is hoped meet with the approval of the readers—one is the increase in the type-page by about 14 percent and the other is the adoption generally of a two-column page in place of the single column formerly used. Both of these have distinct financial advantages and, in addition, result in a more attractive publication.

During the past year, four issues of the Journal were published regularly. These comprised a total of 437 printed pages, and included 64 principal articles and 56 "filler" items. In addition, material was handled for the recurring departments on "Congress News," "Map Information," "Current Surveying and Mapping Literature," etc. As a courtesy to authors, the Editor's office also handled the preparation and ordering of reprints. Correspondence between authors, publishers, and others required the preparation of some 150 letters.

The decision of the Board of Direction to open the pages of SURVEYING AND MAPPING to commercial advertisers has necessitated some liaison work on the part of the Editor with the advertising agency and the publisher. What the full impact of this new venture will be on the Editor's office will not be known until we have gone through several issues of the Journal.

Toward the latter part of 1951, it became increasingly apparent that the work of preparing SURVEYING AND MAPPING for publication required a greater division of responsibility than existed up to then. Acting on the recommendation of the Special Committee on Publications Policy in its report of February 27, 1951, the Board of Direction named Robert C. Eller of the U. S. Geological Survey as an assistant editor of SURVEYING AND MAPPING. From the standpoint of our Journal, I consider this to be one of the most progressive steps that has been taken during the past year. The naming of an assistant editor to work with the Editor-in-Chief will not only mean a sharing of responsibility, but it will also insure continuity to the Office of Editor and maintenance of the high quality of our Journal as developed through many years of trial and error. It is my recommendation that this type of set-up be maintained throughout the life of our organization and if and when necessity demands, an additional assistant editor be named.

I am grateful to the Publications Committee for its fine cooperation during the past year in the preliminary processing of material for publication. I also wish to thank authors who have contributed papers and other material. Finally, I wish to express my appreciation to Mr. Eller for his assistance in getting out the last two issues of SURVEYING AND MAPPING. He has been extraordinarily cooperative and has been quick to grasp the full significance of the multiplicity of problems associated with the editorial work of the Journal.

A. L. SHALOWITZ
*Editor-in-Chief*

* * *

## Budget and Finance Report

The finances of ACSM are healthy at the moment, but how long they will remain so, with the increased costs of all operations and the increased obligations of ACSM, is questionable. It is only through the voluntary work of the many officers of ACSM that it is able to operate thus far on so low a budget.

The annual financial statement for the calendar year 1951 was published on page 85 of the March issue of the Journal and all those interested have had an opportunity to read it. Figures in a report such as this are boring anyhow. I will only say that the receipts for the first quarter of 1952 were $2,700 more than for the comparable quarter of 1951, while the expenditures were $600 more. It must be borne in mind though that two-thirds or more of ACSM's annual income is received in the first quarter, whereas its expenditures are more or less constant throughout the year.

An example of the increased costs is that the publication cost for the four issues of the Journal in 1951 was $7,459, whereas the comparable cost of the first two issues this year is $4,765, or 64 percent of last year's total.

The preliminary report on the Twelfth Annual Meeting indicates that, financially, it will be by far the most successful of our annual meetings.

K. T. ADAMS
*Chairman*

# Treasurer's Report

Briefly, as of June 10, these are some facts and figures from the treasurer's books, which are inspected and analyzed after the close of each quarter year. During the last four quarters the treasurer wrote checks for a total of $22,780.41 as tabulated below.

The number of delinquents is being reduced slowly, as payments are coming in at the rate of one per day.

FINANCIAL RECORD

| | *Deposits* | *Withdrawals* | *To Savings Account* |
|---|---|---|---|
| 2nd Quarter, 1951 | $ 8,878.19 | $ 9,045.79 | |
| 3rd Quarter, 1951 | 635.51 | 3,012.38 | |
| 4th Quarter, 1951 | 6,181.95 | 4,117.27 | $ 3,000 |
| 1st Quarter, 1952 | 7,260.01 | 6,604.97 | 3,000 |
| | $22,955.66 | $22,780.41 | $ 6,000 |

MEMBERSHIP RECORD

| | *Old* | *New* | *Total* | *Delinquent* | *Sustaining* | *Library* |
|---|---|---|---|---|---|---|
| Dec. 31, 1951 | 1297 | 964 | 2261 | | 15 | 274 |
| June 10, 1952 | 1719 | 530 | 2249 | 542 | 3 | 20 |
| June 18, 1952 | 1812 | 638 | 2450 | 443 | | |

*Treasurer*
RICHARD T. EVANS

# Membership Committee Report

The membership roster published in the April–June issue of the Journal lists 2,430 individual members and 270 library members in good standing on December 31, 1951; the geographical distribution being not only throughout the 48 States, but also in the District of Columbia, Alaska, Canal Zone, Guam, Hawaiian Islands, Puerto Rico, the Virgin Islands, and 37 foreign countries. Thus far this year 451 new individual members and 15 new library members have been added, making a grand total, in both categories, of 3,166 members, as of the last day of the 12th Annual Meeting, June 13, 1952.

Although the above figures indicate a healthy growth of ACSM, it must be borne in mind that net gains in membership, just as in business, can only be determined after the losses incurred during the same period have been deducted. Unfortunately, the indications at present are that the individual membership losses for 1952 due to resignations, deaths, failure to pay dues, etc., will definitely exceed 10 percent unless something is done during the latter part of the year to reduce the losses. Assuming that 800 new members will be obtained during the year, a 10 percent loss in 1951 membership would reduce the net gain to 557, and a 20 percent loss would reduce it to 314. The actual net gain for 1952 will probably fall between these two figures.

Far too large a percentage of the dropped memberships is the consequence of members who, although they recognize the potentialities of ACSM and have every intention of supporting it, fail to reach promptly enough for their checkbooks when notices of dues arrive, and eventually fall by the wayside. These are the members hardest to lose, and it is earnestly hoped that many of them will make new applications and start over again. Also, there is a relatively large number who have joined ACSM under more or less pressure, either on the part of enthusiastic friends, or by their superiors in the organizations in which they are employed. Too often it is not explained to them that they have a definite responsibility to help support ACSM, whose main objective is to raise the standards of the surveying and mapping professions, and to improve the

status of the many thousands of capable and conscientious men and women who make their livelihood in this most important profession.

In the hope of reducing membership losses and improving the stability and quality of our membership generally, the following suggestions are made:

(*a*) Reach for your checkbook promptly on receipt of your first notice of dues. Prompt payment cuts costs and reduces chances of errors in mailing lists.

(*b*) Sell ACSM to a prospective member by explaining its objectives, and emphasizing that he has a responsibility to work for these objectives.

(*c*) Broaden the scope and usefulness of the Journal by adding to the Publications Committee two members—one for contacting editors of local sections and encouraging them to submit reports, programs, and suggestions for the Journal; and the other for encouraging and soliciting brief write-ups of short cuts, new wrinkles, etc., such as are used in the interesting and instructive advertising material published in "The Surveyor's Notebook" by W. and L. E. Gurley.

In conclusion, the chairman wishes to convey thanks and appreciation to the large number of members and local sections who have taken an active interest in building up the membership of the Congress. While it is not possible to name them all, special mention must be made of the excellent growth in California, made by both the Northern California and Southern California Sections. As a result, California now leads all the States and the District of Columbia in membership.

F. S. BORDEN
*Chairman*

## Publications Committee Report

Your Publications Committee, during the last year, reviewed and edited for publication 50 principal articles and papers, besides editing numerous shorts and fillers and the regular features of the Journal, such as Congress News, Surveying and Mapping Literature, Distinctive Recent Maps, Map Information, New Members List, etc. Two major efforts were the preparation of the 2-year cumulative index and the membership roster.

The members of the committee have labored valiantly and practically anonymously and they deserve your support and my thanks for their efforts. The members' names are published prominently in each issue of the Journal. It is only necessary to mention by name that W. O. Byrd, representing the Control Surveys Division, had to resign for personal reasons and Prof. Milton O. Schmidt, University of Illinois, has been appointed in his place.

May I take this opportunity to plead with members of the Congress to forward their written contributions to the Journal directly to the committee member representing the Technical Division most concerned with the subject matter. This will expedite handling and if there are any questions about the subject, they can be handled directly. Items of news interest that are appropriate for use in the "Congress News" department are particularly wanted. These should be prepared in duplicate, double-spaced, and on separate sheets of paper with an appropriate short heading, and not included ramblingly in a letter from which it is difficult to extract them.

Potential authors need not feel badly that in a few cases a contribution has been rejected by the Publications Committee. It is not possible, nor is it desirable, to publish every article submitted. There are many reasons for an occasional rejection, and it is only by selection that the high standard of the Journal can be maintained.

K. T. ADAMS
*Chairman*

## THIRTEENTH ANNUAL MEETING, MARCH 23–25, 1953 WASHINGTON, D. C.

# Resolutions Adopted at Twelfth Annual Meeting

The following Resolutions were unanimously adopted by the American Congress on Surveying and Mapping at the Twelfth Annual Meeting at Washington, D. C., June 13, 1952.

## RESOLUTION ON THE ENGINEERING STATUS OF THE SURVEYING AND MAPPING PROFESSION

*Whereas*, the U. S. Civil Service Commission has decreed in effect that in the operations of the Government surveying and mapping agencies, there is no work that can be considered to be engineering; and

*Whereas*, surveying of all types and particularly surveying for the purpose of providing data for the production of maps (including geodetic, topographic, hydrographic, and cadastral surveys as well as surveying techniques utilizing photogrammetry and electronics) have long been considered to be a branch of civil engineering; and

*Whereas*, the Civil Service Commission's order may ultimately affect the standing within the engineering profession of many engineers outside Government service, including members of the faculty of educational institutions, members of private practice organizations, and engineer employees of State, county, and municipal governments; and

*Whereas*, it is believed that a clear statement on this question by the recognized leaders of the surveying and mapping profession is necessary before any organization can hope to challenge successfully the Civil Service Commission as to the justice and wisdom of its edict, now therefore be it

*Resolved*, that, in the opinion of the American Congress on Surveying and Mapping, planning, execution, and direction of the professional surveying activities which are necessary for the production of the Government's standard series of maps and charts, as well as similar work elsewhere are profesisonal engineering, and that the public interests which are dependent on the quality, consistency, and economy of such work will be best served if it is directed and performed as much as possible by professional engineers having appropriate qualifications.

## RESOLUTION ON THE TWELFTH ANNUAL MEETING

*Resolved*, that the members of the American Congress on Surveying and Mapping attending the Twelfth Annual Meeting hereby express their appreciation to Chester E. Kowalczyk, General Chairman, Annual Meeting; to the members of the Program Committee; and to all those whose services have contributed to making this a successful meeting.

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# Northern Virginia Chapter Organized

A Northern Virginia Chapter of the Virginia Association of Surveyors, Inc., was organized and "Charter Night" of this group was held at the George Mason Hotel, Alexandria, Va., on June 19, 1952. Twenty-three paid certified land surveyors, comprising about 75 percent of those practicing in the area, were included in the charter membership. The organization was the result of activity begun in January of this year. Progressive steps included the drafting of a preliminary constitution which was mailed to all certified in the area, and a final draft is being made by the group that responded to the first call. The final draft will also be sent to all certified in the area.

The carefully worded constitution included a provision that its dues and membership would automatically include mandatory dues and membership in ACSM. It was believed that ACSM provided the only current journal on surveying in the country, and that the proximity of the group to Washington would allow a maximum of its members to enjoy the full benefits of ACSM. The State Association is already an affiliate member, but the Chapter became the first professional surveyor group to include mandatory ACSM membership in its charter constitution. Also, one card is being made to include Chapter, State, and ACSM membership.

Charter night started with cocktails, followed by a chicken dinner. All the Virginia Association directors were present, and Walter S. Dix, Executive Secretary of ACSM, was the guest speaker. Mr. Dix outlined the history of ACSM and answered many questions concerning its activities. State president R. V. Carter welcomed the Chapter into the Association with the hope that this first chapter in the State would be followed by chapters in other areas. Acting chairman V.

H. Ghent outlined many directions which the Chapter could take if it wanted to expand its activities from the basic four meetings per year. Each member was called on in turn to outline his views of what the Chapter should do. All agreed to the idea that slow, steady progress was the answer. Election of charter officers followed, and a unanimous vote was cast for the slate presented by the organizing committee.

The following officers and directors were elected:

*Officers*

Victor H. Ghent, *President*
Tom H. Johnston, *Vice President*
Carson V. Carlisle, *Secretary-Treasurer*

*Directors*

R. J. Ratcliffe (2 years)
Cecil J. Cross (2 years)
Dan M. Maher (1 year)
James D. Payne (1 year)

## Northern California Section

The Northern California Section of ACSM, which was officially approved December 17, 1951, met on April 18, 1952. Robert L. Wing, Supervising Hydraulic Engineer in the California State Engineer's Office, and a former director of ACSM, was the principal speaker. His subject was the "Ultimate Reclamation of Marsh, Tide, and Submerged Lands in the San Francisco Bay Area," based on a recently completed study of reclamation in the San Francisco Bay area, which was an outgrowth of the so-called Reber Plan, described in an article in the *Saturday Evening Post* of November 18, 1950.

The officers of the Northern California Section are:

*Officers*

V. S. Seward, *Chairman*
C. J. Aggeler, *Vice Chairman*
Charles O. Greenwood, Jr.
*Secretary-Treasurer*
Logan N. Muir, Jr., *Editor*

*Executive Board*

C. A. Biever
H. A. Waterfall
Norman O. Glover
C. A. Wooldridge, Jr.

## Southern California Section

The midsummer dinner meeting of the Southern California Section was held on June 17, 1952, in one of the private dining rooms of the Rodger Young Auditorium in Los Angeles.

After much roast beef was consumed and cigars were burning furiously, those present thoroughly enjoyed a talk entitled "The Point of Beginning in Public Relations," given by Don Sweeney, public relations representative of the General Petroleum Corporation.

Afterwards, a color motion picture was shown, illustrating the geodetic operations of the U. S. Coast and Geodetic Survey. Comdr. Dan Whelan, Jr., of that organization, accompanied the film with interesting commentary.

## Texas Section

The Directors of the Texas Section met at the Houston Engineers' Club, Houston, Tex., on April 16 to make plans for 1952. Mr. O. E. Young, Chairman, presided.

E. C. Morse, Chairman of the Program Committee, reviewed the programs of the meetings held in 1951 and suggested the following subjects from which programs for the current year can be planned:

(1) Panel Discussion of ACSM Survey Standards.

(2) Outline of Procedure for an Oil Company Block Survey.

(3) Panel Discussion of ACSM Schedule of Fees and Ethical Practices, such as a question of doing private work in competition with salaried engineers and surveyors.

(4) Complex Survey Problems.

(5) Panel Discussion of the Merits or Demerits of the Texas Plane Coordinate System.

Mr. W. H. Wilson mentioned the possibility of a study of a Surveyors' Law. The study could comprise what regulations should be in the proposed Texas Surveyors' Law and to what extent the present law should be amended. Mr. Morse suggested that Mr. Young appoint J. S. Boyles to make a research on needs for the proposed law. The question was raised to whether our membership could decide what should constitute the proposed law.

Mr. Morse later suggested that the ACSM could help the surveying profession by sponsoring a Civic Betterment Plan. Mr. Morse, who deplored the loss of the city monument system on San Jacinto Street due to new paving, offered to assist in presenting a new program of re-establishment of city monuments to the Houston Municipal Administration. This program would be presented to the public by the ACSM as a civic interest.

Mr. Morse also suggested that the Texas Section look into the needs of a 200-feet-to-the-inch topographic map of Houston and its environs. The program chairman suggested that George Lacy take the lead in making a study of the need for local topographic mapping improvements.

Mr. Cornitius suggested that a dinner or other refreshments be given at one or more meetings each year.

The 1952 officers of the Texas Section are:

O. E. Young, *Chairman*
R. M. Atkinson, *Vice Chairman*
R. A. Washburn, *Vice Chairman*
W. H. Wilson, *Vice Chairman*
Forrest Daniell, *Secretary*
G. M. Livingston, *Treasurer*

The following are the 1952 committee chairmen:

E. C. Morse, *Program*
L. C. Cornitius, *Membership*
Clifton E. King, *Arrangements*

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The Fifth Meeting of the Texas Section was held on May 21, 1952, at Hugh Wilkin's Armadillo Club in Houston. O. E. Young, Chairman, reviewed the formation of the Texas Section and its achievements under the leadership of Grant W. (Buck) Herzog, the retiring chairman.

Mr. Herzog presented Albert C. Stiefel, Chairman of the Committee on Public Relations and a member of the Committee on Map Appreciation and Use, both committees of the National ACSM. Mr. Stiefel commented on the need for active local sections, such as the Texas Section, and on the panel on Map Appreciation at the 1951 Annual Meeting in Washington. He mentioned that the Texas Section should make a study of the possible need for map reference libraries and of the localities where they should be located.

E. C. Morse, Chairman of the Program Committee, introduced R. L. Sargent of the R. L. Sargent Company, Houston, Tex., who spoke on the care, adjustment, and repair of surveying instruments. His talk was supplemented with slides and demonstrations. Mr. Sargent discussed the adjustment of the dumpy and wye levels, transits, and alidades. He also explained the proper method of cleaning lenses and instruments. His speech covered the field of repair and adjustment of instruments so well that several members have urged Mr. Sargent to prepare his talk for publication in the quarterly journal, SURVEYING AND MAPPING.

The meeting closed with a display of foreign instruments to the 65 members and guests.

FORREST DANIELL
*Secretary*

# ACSM Affiliate Meets

The Fourth Annual Meeting of the Virginia Association of Surveyors, Inc., was held on February 23, 1952, at the George Mason Hotel, Alexandria, Va. Twenty-nine members were present. The annual business of the Association was transacted, the charter and by-laws of the Association were amended, and State legislation of interest was discussed. The 1952 officers of the Association are as follows: R. V. Carter—*President*; J. D. Payne—*Vice President*; and V. H. Ghent —*Secretary-Treasurer*.

## Personals

Col. Herbert Milwit has assumed command of the Engineer Research and Development Laboratories at Fort Belvoir, Va. A West Point graduate, he later attended the University of California, where he earned his Bachelor of Science degree in civil engineering.

Colonel Milwit has had many engineering and surveying assignments. In 1934 he graduated from the Engineer School Company Officers Course at Fort Belvoir. He served with the 29th Engineers in Portland, Oreg., from 1939 to 1942, returning to Fort Belvoir for a short tour with the 30th Engineers in May 1942.

One of his most important jobs was chief of the intelligence division of the Office of Chief Engineer in the European Theater of Operations from June 1942 to December 1945. From this assignment he went to the Office, Chief of Engineers, in Washington, D. C., where he served both as Deputy and as Chief of the Engineer Intelligence Division until May 1947. Recently, he was on duty with the Photographic and Survey Section of the Joint Intelligence Group of the Joint Staff.

He holds the Legion of Merit, the Bronze Star Medal, the Order of the British Empire, the Order of Leopold II from Belgium, and the Croix de Guerre with Palm from France.

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Miss Gail Peters, a 22-year-old cartographic draftsman in the U. S. Geological Survey, broke the American record for the 200-meter breaststroke swim at Indianapolis early in July and thereby won a place on the women's Olympic swimming team. Her time for the race was 3:02.6. This is the third American swimming record for Miss Peters this year. In earlier meets she broke the 200-yard breaststroke and the 300-yard individual medley marks.

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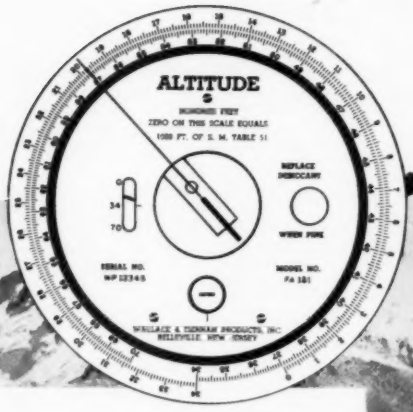


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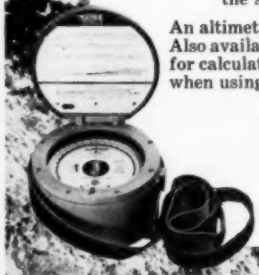

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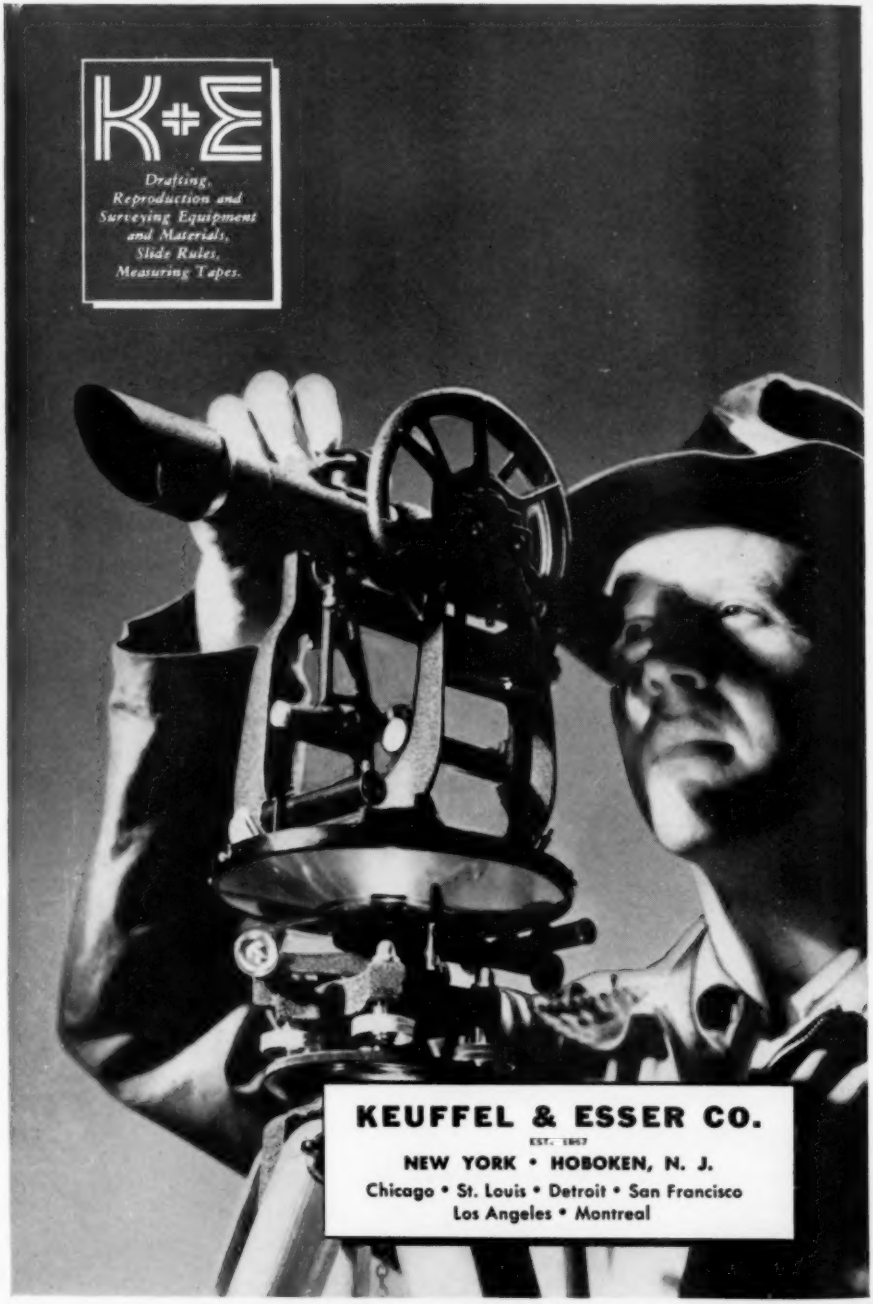
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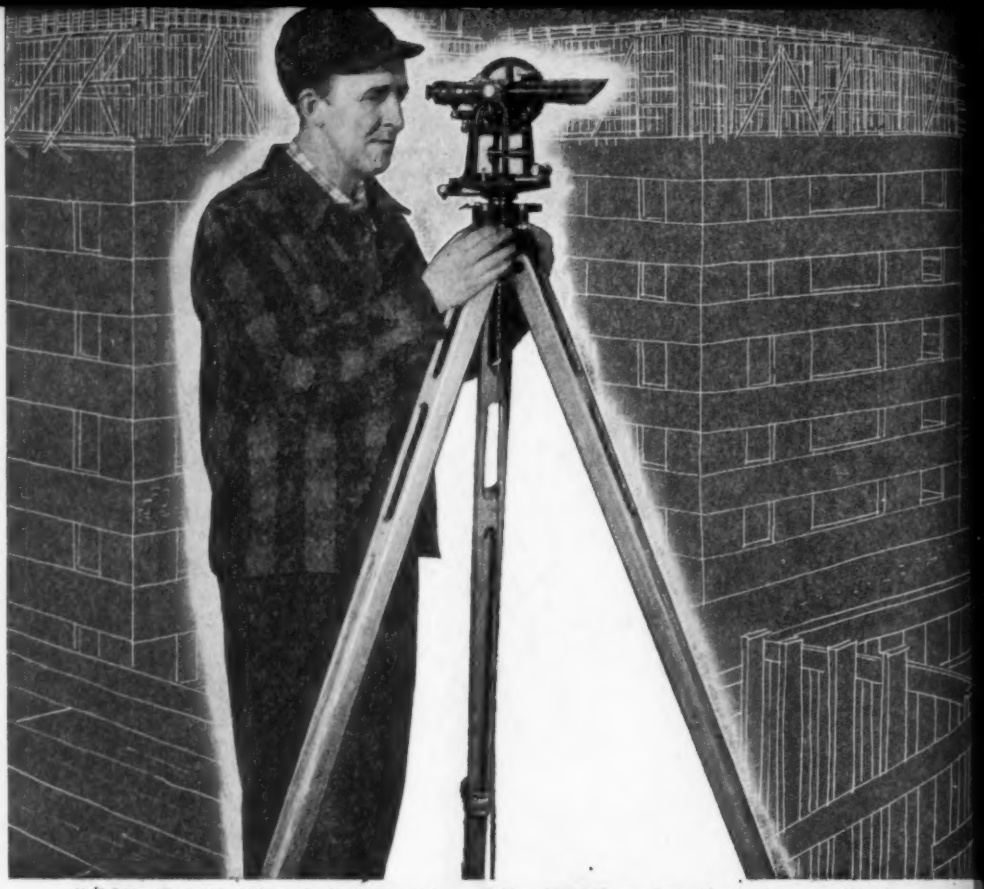

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